

Environmental, Social, and Economic Cost/Benefit Analysis

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

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Purpose

This technical paper is the fourth in a series of five papers written by the Arizona Department of Environmental Quality (ADEQ) to support stakeholder engagement during the adoption of Arizona's State Surface Water Protection Program (SWPP). This paper is not policy. The SWPP papers are intended to be problem-solving artifacts to assist ADEQ in gathering information related to filing a Notice of Proposed Rulemaking (NPRM) for the SWPP. ADEQ believes that these papers will focus public engagement on the scientific basis for agency decisions and drive productive conversations regarding SWPP implementation.

Specifically, this paper will outline the environmental, social and economic cost benefit analysis ADEQ will use to list/delist waters and apply water quality standards at specific levels. At a high level this paper addresses:

- ADEQ's process to develop a methodology to formulate an appropriate economic, social and environmental (ESE) cost/benefits analysis for SWPP implementation;
- Elements to be considered in a water quality benefit/cost modeling process;
- A modeling framework for generating water quality benefit/cost estimates,
- An overview of benefit/cost valuation methodologies;
- A forecast of how ADEQ's ESE model will function.

This is an early draft of this specific technical paper and it does not include ADEQ's final conclusion. The agency recognizes the amount of stakeholder interest surrounding this process and wanted to share ADEQ's methodology for building an ESE process as soon as possible. There will be significant revisions to the final model before the second draft of the paper is released. Readers should note that the conclusions drawn in this paper are not final and ADEQ welcomes stakeholder feedback and suggestions on what specific inputs should be included in the agency's final model.

Introduction and Background

ADEQ must publish the Protected Surface Waters List (PSWL) as part of the SWPP rulemaking. A.R.S. § 49-221 requires that the PSWL contain all waters meeting the current federal definition of a Waters of the United States (WOTUS), protection for Arizona's 8 major rivers, and protections for any waters not meeting the current definition of a WOTUS (non-WOTUS) used for specific purposes. Additionally, the legislation requires that the Director adopt "procedures for determining economic, social and environmental costs and benefits." The procedures for

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¹ § 49-221(G)

determining the economic, social and environmental costs and benefits of the new SWPP program will be applied in two ways:

- 1. If the water is not categorically excluded from the SWPP as defined in § 49-221 and the economic, social and environmental benefits of adding the water outweigh the economic, environmental and social costs of excluding the water from the list, the water *may* be added to the PSWL.²
- 2. In adopting water quality standards at a particular level or for a particular water category for non-WOTUS protected surface waters.³

High Level Overview of ADEQ Process

Although the requirements specific to the SWPP were introduced in HB2691 (2021), ADEQ has performed cost/benefit analyses in a number of historical contexts.⁴ § 41-1055 has required a formalized Economic Impact Statement for agency rulemakings since 1995. The agency has frequently relied on outside expertise to perform baseline economic reports that inform our policy decisions. In the state fiscal year 2022 (FY22), ADEQ received specific line-item allocations in the budget to develop economic analysis for the SWPP rulemaking.

ADEQ contracted with McClure Consulting, LLC (McClure), to produce two separate reports on the set of procedures ADEQ could adopt for determining economic, social and environmental costs and benefits of the SWPP. The original report was delivered on July 7, 2021, and a draft second report was delivered on March 4, 2022. This technical paper sources extensively from those two reports and serves as a guide to how ADEQ will deploy them in rulemaking. The reports in their current forms are attached as appendices.

The first report drafted by McClure, focused generally on the process ADEQ could use to model economic, social and environmental costs and benefits. The second report provides deeper analysis and delves into specific case studies that ADEQ will use to display how the procedures adopted in the rulemaking will be applied.

In addition to the reports produced by McClure, ADEQ conducted a 50-state survey to provide an overview of how other states conduct similar analyses. That report is included as an appendix to this technical paper.

² § 49-221(G)(4)(c) and § 49-221(G)(6)

³ § 49-221(A)

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⁴ See Annotated bibliography from *DRAFT* McClure report 2. ADEQ has built a significant library of cost/benefit analyses through our Water Quality Document Catalog. The agency provided those documents to our contractors as historical reference for our valuations. Interested parties can generate a deeper understanding of the ADEQ research process by looking through the annotated bibliography produced by the contractors.

McClure Report #1

For the first report, ADEQ asked McClure to produce a draft modeling approach to demonstrate how the procedures adopted in the SWPP rulemaking might work. ADEQ is familiar with modeling in a number of environmental contexts, so pursuing a model-based approach is a logical outgrowth of institutional expertise within the agency. ADEQ can provide accurate costs of our own regulatory programs through known and quantifiable internal costs. Additionally, ADEQ can estimate costs to permittees through our historic economic impact statements associated with rulemaking. However, for environmental benefits, there is no easily ascertainable market price as the benefits often relate to "goods and services" that are not traded in markets and therefore are not subject to market-based pricing.

Since there is a need for the economic value of non-market environmental resources to be expressed in market prices, ADEQ's consultants provided a literature review for valuing non-market goods and worked with agency staff to evaluate their applicability to the SWPP. Then, McClure built a draft framework for an economic model to estimate a market value of those resources. The initial report presented the agency with a number of different techniques and research to use to build the required procedure.⁵

Modeling Elements

McClure Consulting proposed various valuation methods that all came with their own unique practical and scientific challenges. For example, using a survey-based methodology to derive hypothetical costs and then extracting the kind of information actually wanted from a survey process would require ADEQ to do an additional level of analysis beyond the scope of the SWPP rulemaking. If ADEQ had to ask every fisherman the hypothetical market value of a day of fishing, the amount of man-hours the agency would need to dedicate to generate a statistically significant answer to that question would be enormous. Given these real-world challenges of developing a valuation procedure, the concept of benefit transfer has substantial appeal to ADEQ as the agency must produce a sweeping amount of analyses to adopt the SWPP.

The benefit transfer method is used to estimate economic values for environmental benefits by transferring available information from studies already completed in another location and/or context. For example, values for recreational fishing in a particular state may be estimated by applying measures of recreational fishing values from a study conducted in another state. Thus, the basic goal of benefit transfer is to estimate benefits for one context by adapting an estimate of benefits from some other context. Benefit transfer is often used when it is too expensive and/or there is too little time available to conduct an original valuation study, yet some measure of benefits is needed. It is important to note that benefit transfers can only be as accurate as the

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⁵ See McClure Report 1

initial study. 6 However, this approach comes with challenges of its own, including finding case studies that align with the local policy under consideration.

Based on the first draft McClure paper, ADEQ expressed interest in applying a benefit transfer approach during the deployment of our SWPP program. This approach can be used in a way that will explicitly incorporate opportunities for stakeholder input to supplement and validate the values generated by the model.7

The first suggested element topics are wide-ranging, from administrative to scientific influences. The modeling elements used in this approach are discussed at length in the first report.8 The appendix list of the draft report is annotated with questions and commentary intended to help guide the benefit/cost modeling process.

The initial framework in the first draft report did not focus on applying the model in specific situations, although one high-level process did entertain the idea of setting individual pollutant parameters for designated uses. ADEQ and the McClure began work on scoping the second leg of our review to narrow that framework and apply it in specific contexts. Any procedure ADEQ adopts must be consistently applied across the SWPP decision making process.

Conceptual Modeling Framework

The diagrams on the following pages are representative of the factors and variables of the economic benefit/cost modeling framework ADEQ and McClure developed as high-level guard rails for the SWPP economic, social and environmental cost benefit analysis. The early stages of the draft model were largely conceptual, and incorporated the analysis for standards and water body listing into one cohesive analysis. While this was useful during the scoping process, the final version of the ADEQ rule will separate the analyses. This technical paper addresses the models at a high-level, but interested parties should read the contractor's report for more in-depth information. The contractor's report provides nuanced commentary about conceptualizing cost/benefit models and will help any reader understand the two flowcharts on the following pages.

Figure 1 is a conceptualized flowchart of how ADEQ could start designing a process to assign the economic, social and environmental benefits and costs related to individual waters. As the early model incorporated the analysis for standards and the water body listing into one, the process also works for standards. In the diagram, ADEQ would start the flow by making a decision regarding the adoption of standards levels for different contaminants and then applying them to the specified surface water. Then, ADEQ would apply that specific level for that specific waterbody to demonstrate the impact the decision would have on the uses of the water.. The conceptual nature of this original model limited McClure's analysis to three or four uses within two broad categories. This design could then be used for any of the ESE categories of social.

⁶ https://www.ecosystemvaluation.org/benefit_transfer.htm

⁷ See McClure Report 1

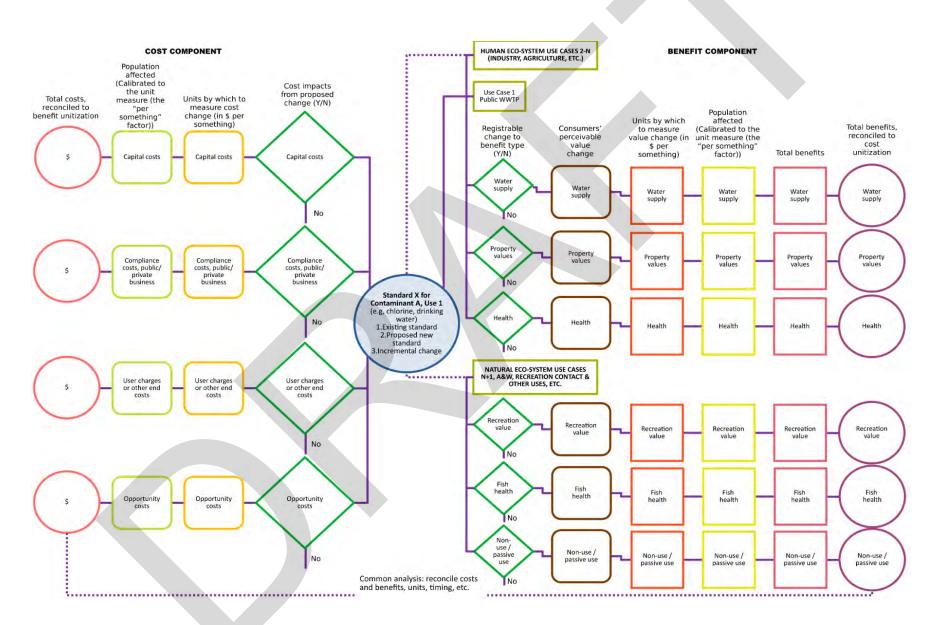
⁸ ld.

economic or environmental costs/benefits. While this model will not ultimately be adopted by ADEQ, it was extremely helpful during the process of beginning to conceptualize the flow of the valuation process.

Figure 2 expands the analysis to setting water quality standards at a certain level or for a certain type of water. Once again, this was largely a conceptual model that was used to begin to demonstrate the different amount of variables that ADEQ could take into account when performing our economic, social and environmental cost benefit analysis. Specifically, this tool helps illustrate the complexity in assigning "value" that is generated in protecting surface waters. The individual decision points in this flowchart help indicate the complexity that would be inherent in ADEQ's decision making process without any further analysis.

Figure 1. Draft Benefit/Cost Model Overview WATER BODIES FOR LISTING/DELISTING Application of Contaminant Standards standards Yes/no; levels Costs and benefits Benefits and costs Natural ecosystem uses Human ecosystem uses Institutional Wildlife etc. **Business** Generally valued attributes, eco-system services Agriculture Recreationists Households Segmentation/allocation of costs and benefits to recipients, avoiding double counting, etc. Recreationists; Households recreation contact Nonuse "valuers" General public

Figure 2. Draft Model Detail



McClure Report #2

The process of developing the first McClure report highlighted areas that needed further analysis. Simply put, the process of assigning "value" in a vacuum is untenable for the purposes of SWPP adoption. Each individual surface water in Arizona has unique characteristics that require a valuation approach that takes into account local characteristics. With this in mind, ADEQ entered into an additional contract with McClure to hone the analysis in a way that would allow some real world results to be shared with stakeholders before the SWPP NPRM was published. ADEQ received the first draft report on March 2, 2022, and provided input to McClure. McClure is currently editing the draft based on our input, and the final report is due to ADEQ by the end of April. Again, the ESE paper will be edited to include information from the final McClure report.

Example Water Analysis

The first McClure report contains a section that explains the limitations of the recommended benefits transfer approach. The largest limitation on the recommended approach was simply that it wasn't geared towards any particular real world scenario. In response, ADEQ prepared three categories of "example waters" that may potentially be added to the PSWL. The contractor based their modeling result on the three scenarios labeled below.

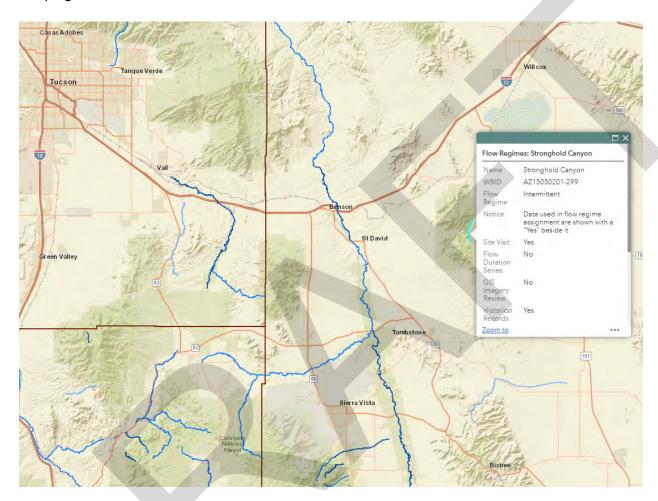
ADEQ will use these classes of waters as a framework for comparison for any waters added to the PSWL through the cost/benefit analysis. The example waters that we've listed all contain elements that will help ADEQ value the unique characteristics of Arizona's surface waters. The requirement to consider those unique characteristics in ADEQ's valuation methodology is expressed in §49-221. Using these example waters will help ADEQ explain the environmental, social and economic costs/benefits of our SWPP program in relatable terms, rather than solely through a gargantuan, esoteric modeling process.

1. Class 1 – Sky Island Stream. Representative Water – Stronghold Canyon.

Sky Islands are isolated mountain ranges in southeastern Arizona. Some of the mountains rise more than 9,000 feet above the surrounding desert floor making the lowlands and high peaks drastically different. These mountains contain a number of perennial or intermittent surface waters that may have no significant nexus to a traditionally navigable water as the water generally infiltrates or evaporates in the deserts surrounding the sky island. In the mountains, these streams provide valuable habitat, recreational opportunities, and some may hold a level of cultural significance.

ADEQ has picked Stronghold Canyon as an example for this category of waters. The Cochise Stronghold is located in southeast Arizona within the Dragoon Mountains at an elevation of approximately 5,000 ft. This woodland area lies in a protective rampart of granite domes and sheer cliffs which were once the refuge of the Apache Chief Cochise and his people. Perennial

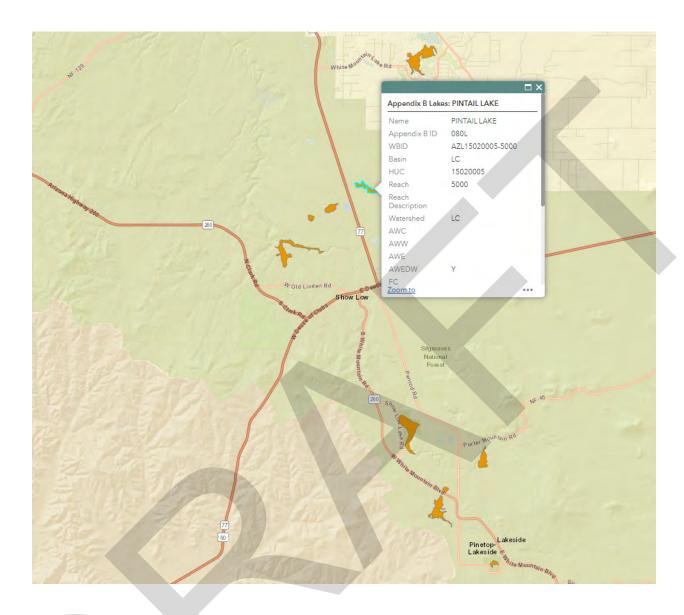
springs feeding streams in this area provide water to animals and historically to the people that lived in the area. Now located within the Coronado National Forest, the area remains a popular recreation destination with opportunities for hiking, birding, climbing, mountain biking and camping.



2. Class 2 – Isolated Lakes. Representative Water – Pintail Lake, Show Low.

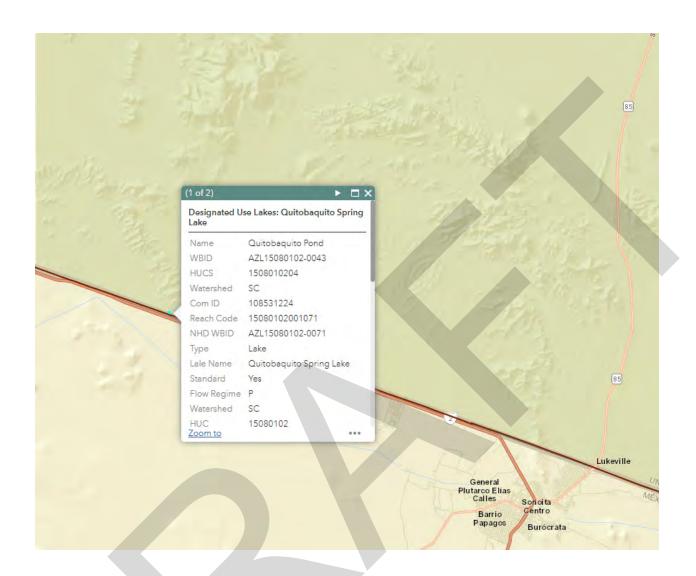
Pintail Lake is part of a man-made wetland created from treated water from the City of Show Low. Developed in 1979, it is recognized nationally as one of the first of its kind in the country. Water covers approximately 50 to 100 acres at any given time due to seasonal or climate variations. The lake is an important source of water for local and migrating wildlife, including a variety of birds and big game such as elk and pronghorn antelope. Hunting is allowed in the area and Pintail Lake is popular with waterfowl hunters between November and January. The area is managed in partnership with the City of Show Low, Arizona Game and Fish Department, Apache-Sitgreaves National Forest, and other parties, including the White Mountain Audubon Society.

⁹https://www.whitemountainaudubon.org/birding-hotspots/#:~:text=Allen%20Severson%20Memorial%20Wildlife%20Area,its%20kind%20in%20the%20country.



3. Class 3 – Ecologically, Culturally, or Historically significant water. Representative Water – Quitobaquito Pond.

Quitobaquito pond is located in the Organ Pipe Cactus National Monument, which was created in 1937 by President Franklin Roosevelt. Historically, the spring-fed pond was located on a prehistoric trade route known as the Old Salt Trail. This route was used to trade salt, obsidian, seashells, and other commodities from the salt beds of Sonora, Mexico. The pond remains culturally significant to the Tohono O'odham Nation located in southern Arizona. From the 1860s and until the area was designated a national monument, the water was used by the settlers for their homes and businesses and to irrigate fruit trees and crops. The pond is home to a species of turtle and snail unique to the pond, as well as a butterfly that coexists solely with a plant found only in this area.



Leveraging Existing Cost/Benefit Analyses

One of the main goals of the SWPP is to provide consistent and clear regulation. To ensure that the adopted procedure for determining economic, social and environmental costs and benefits is familiar, ADEQ and McClure have done an extensive literature review to inform our decision making.¹⁰

ADEQ specifically asked our contractors to leverage the economic analyses used by the U.S Environmental Protection Agency (USEPA) in current WOTUS rulemakings. ADEQ believes that these are some of the most relevant studies to take place regarding the cost of surface water regulation. The second draft contractor report contains an extensive breakdown of the USEPA's process and makes Arizona specific adjustments. Additionally, the models proposed in the second McClure report source extensive amounts of information from past Arizona rulemaking to help make those assessments.

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¹⁰ See Appendix C. ADEQ has done a thorough review of each state's laws on point in addition to the annotated bibliography in the contractor report.

Preliminary Model Structure from McClure Report #2

The preliminary model structure is discussed at length in the draft McClure Report #2. The model is not yet finalized, but the report is nearing completion. ADEQ recommends that interested stakeholders reference the economists report to find an in-depth discussion. ADEQ will update this technical paper with the final version when it is complete. Functionally, the final model will:

- Illustrate how multiple cases, conditions, etc. fit into a framework having multiple commonalities along with distinct components.
- Be designed to both summarize a process and link, conceptually and computationally, to the submodels that relate to the whole.
- Be user-friendly, "transportable," and adaptable.
- Encompass complexity and still remain comprehensible and media manageable.

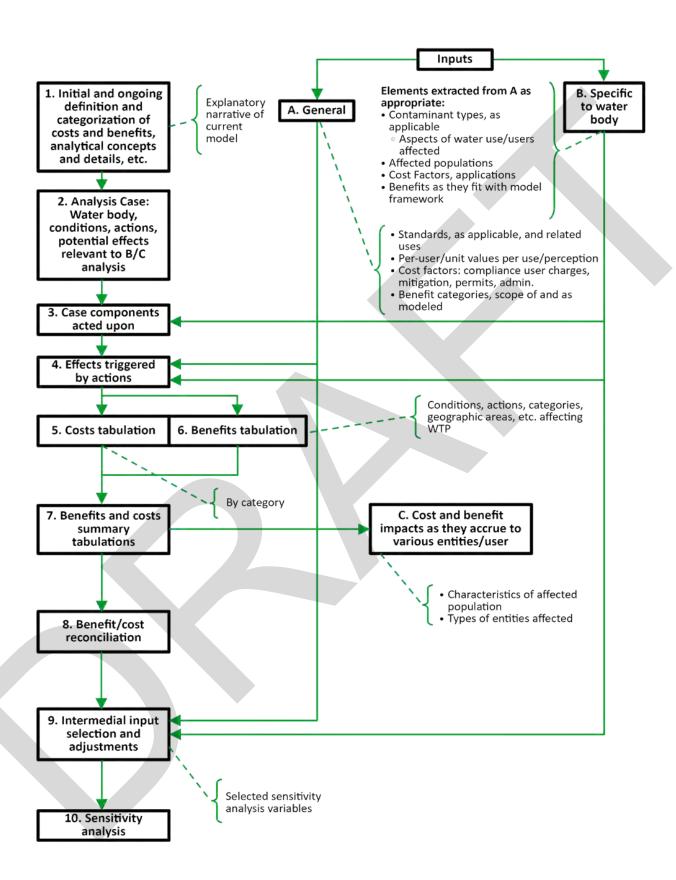
The final model will be delivered as a workable excel spreadsheet that ADEQ can use in the SWPP rulemaking. The updated model is outlined on the following page and includes.

- 1. Inputs, general:
 - a. Standards by water type, if/as applicable to modeling, and relationship to uses, etc.
 - b. Per-user values tied to specific water use types, such as specific recreation activities, etc.
 - c. Cost factors: permitting or other compliance, for public and private entities; user changes per unit by type; consideration of other factors such as health impacts.
 - d. Benefit categories.
- 2. Inputs, specific to a water body:
 - a. Contaminants, standard, influence on uses.
 - b. Human conditions: water supply, recreational potential, passive use/appreciation, property values.
 - c. Aquatic and wildlife conditions: variations by climate, effluent-dependent, ephemeral, etic.
 - d. Affected populations by type of interaction.
 - e. Cost factors: any variation from general factors based on specifics of water body; opportunity costs.
 - f. Benefits: full scope and according to how topics fit into EPA-based model framework.
- 3. Costs tabulation
- 4. Sensitivity analysis component: Review of how the overall model structure relates to the specific analysis conditions in ways that could tend to over/underestimate costs/benefits.
- 5. Affected entities
 - a. For benefits: geographic and demographic description of affected populations that are both "local" and "nonlocal" with respect to water body

b. For costs: types of entities affected, with costs allocated among them to the extent possible.

Figured 3. Annotated Updated Draft Model Concept

Figure 3 is another conceptual flow chart that ADEQ has included in this draft of the technical paper to illustrate the potential inputs the agency will use in the cost/benefit analysis. This updated concept better reflects the ultimate model ADEQ will deploy during SWPP adoption. Largely, ADEQ has honed in on the methodology to calculate costs/benefits. Our valuation methodology draws significantly from the analysis EPA and US Army Corps of Engineers use in their new WOTUS rule. ADEQ is seeking to align our methodology for valuing the benefits of regulation with the extensive analysis done by the Federal government in preparation for changes to the CWA. ADEQ's analysis will use Arizona specific information, but the agency will follow the lead of Federal partners to ensure we're calculating costs/benefits using a methodology that has received extensive review.



Proposed Procedure for Rulemaking

Although the final version of the model is not completed and not provided in this technical paper, ADEQ believes that we can begin providing stakeholders some level of substance about procedure ADEQ will adopt in rule. §49-221 requires that ADEQ must adopt rules outlining a procedure that the agency will use to develop an economic, social and environmental cost/benefit approach. Although those final rules are not written yet, the agency will likely mandate the following:

- 1. ADEQ will use a modeling approach to determine economic, social and environmental costs/benefits during any SWPP rulemaking.
- 2. ADEQ will determine the individual variables used in the modeling approach using a benefits transfer approach.
- 3. ADEQ will make a demonstration of the modeling approach during any SWPP rulemaking when new water quality standards are adopted or additional waters are added to the PSWL.

Conclusion

ADEQ is still in the process of working with McClure to finalize the model that will be used to generate an economic, social and environmental costs/benefit procedure for the SWPP rulemaking including for developing standards as well as listing water bodies on the PSWL. We invite stakeholders to review the process thus far and provide input on the process used and any of the proposed model inputs. While this draft technical paper does not include a final model, much of the process ADEQ has used to arrive at our ultimate model is nearing complete. If you have any question or comments about this paper, please contact ADEQ at:

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ASSESSMENT OF POTENTIAL APPROACHES TO ECONOMIC BENEFIT/COST ANALYSIS OF ARIZONA WATER QUALITY POLICY



Prepared for:

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June 30, 2021

PREPARED BY

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I. Introduction

This document is the primary deliverable in response to the following assignment:

Establish criteria and a modeling framework addressing the economic, social, and environmental costs and benefits from the adoption of water quality standards and for listing or delisting waters for protection within Arizona's Surface Water Protection Program.

Per the direction of ADEQ staff, this assignment is understood to represent an initial scoping phase for potential future augmentation of ADEQ's economic analysis procedures. In this regard, this work product identifies best practices for environmental benefit-cost analysis (BCA) and lays out a conceptual framework for applying these practices to ADEQ's future analytical requirements. This initial work product is intended to assess the general feasibility (and limitations) of a benefit/cost modeling framework and recommended practical analytical techniques to be incorporated into an ADEQ-specific model. It is expected that this initial work will provide a foundation for more detailed modeling efforts that could be subsequently applied in response to specific ADEQ policy proposals warranting economic impact analysis.

The five topic areas below (Chapters III to VII) address several aspects of the recommended modeling framework:

- The set of elements to be considered within a water quality benefit/cost modeling process
- An illustrative modeling framework for generating water quality benefit/cost estimates, summarized in a series of diagrams
- An overview of benefit/cost valuation methodologies how to translate environmental benefit/cost concepts and categories to dollar values
- A summary of the overall complexities, limitations and pitfalls involved in generating estimates associated with water quality actions, particularly estimates of benefits
- Recommended implementation steps, proceeding from the modeling framework

The report was prepared with the cooperation and guidance of ADEQ Water Quality Division personnel.

II. Executive Summary

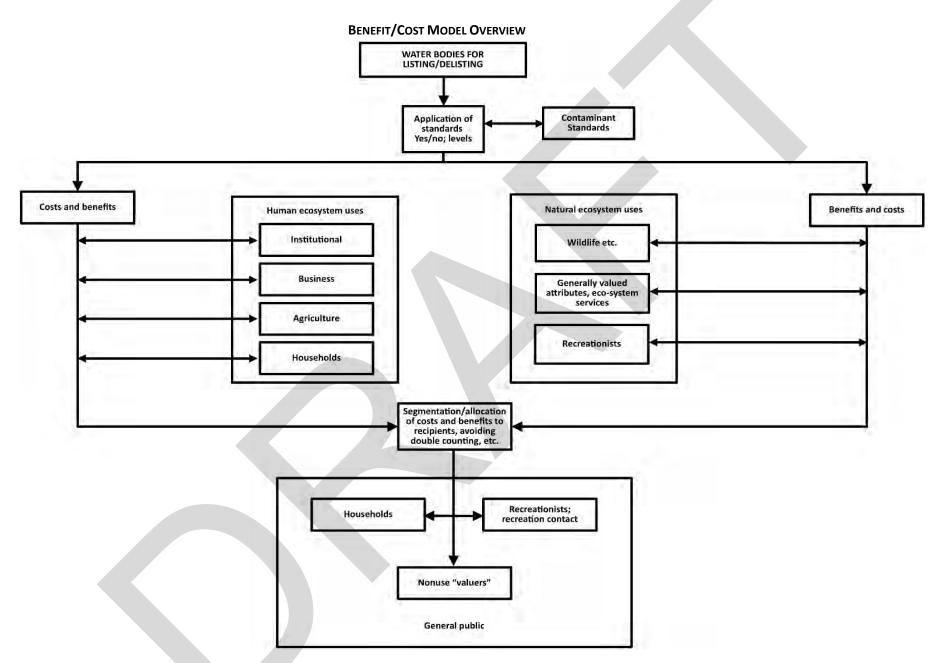
This document establishes criteria and recommends a modeling framework for estimating the economic costs and benefits resulting from the adoption of water quality standards.

The topics included in the report illustrate several aspects of the modeling framework:

- Elements within a water quality benefit/cost modeling process
- An illustrative modeling framework for generating water quality benefit/cost estimates
- An overview of benefit/cost valuation methodologies
- A summary of the overall complexities, limitations and pitfalls involved in generating estimates for water quality actions
- Recommended implementation steps that would proceed from the modeling framework

Illustrative Modeling Framework

The Overview Diagram below summarizes key aspects of the recommended modeling process. In the diagram, decisions are made regarding the adoption of standards levels for different contaminants, and these are applied to uses, as relevant for the contaminant/standard level, within the two overall categories of Human Ecosystems and Natural Ecosystems. The three to four uses within each of these two broad categories will sometimes each have different water quality standards that apply to them as well as different cost and benefit implications. From the standpoint of the general public, gross benefit and cost numbers would then need to be segmented and allocated according to various categories of beneficiaries/payees, with the understanding that different "publics" have different factors associated with their potential gains and losses.



Assessment of Potential Approaches to Economic Benefit/Cost Analysis of Arizona Water Quality Policy

McClure Consulting LLC, with The Natelson Dale Group, Inc.

Analysis Challenges

Benefit/cost analysis (BCA) for environmental protection policies is inherently challenging due to the "non-market" nature of many environmental resources. Whereas the *costs* of environmental regulation tend to be readily quantifiable (or at least reasonably estimable) by the affected parties, the *benefits* often relate to "goods and services" (e.g., clean recreational water and healthy fish populations) that are not traded in markets and therefore are not subject to market-based pricing.

Since the economic value of non-market environmental resources – how much the public would be willing to pay for them (or to improve their quality) – is not revealed in market prices, academic economists have developed a variety of methods for valuing non-market goods. In practice these valuation techniques have been applied in a wide range of circumstances where it is essential to quantify resource values in dollar terms. Although the validity of these valuation methodologies is recognized in academic, legal and policymaking contexts, in practice they are often costly to correctly apply, are difficult for the public to understand, and are subject to wide variations in resulting benefit values.

There are two main types of non-market valuation methods:

- **1. Revealed preference methods.** Revealed preference methods use observations of purchasing decisions and other behavior to estimate non-market values. For example:
 - The <u>travel-cost method</u> uses recreation expenditures and travel time to impute the value people place on visiting a specific site (such as a national park); and
 - The <u>hedonic pricing method</u> attempts to isolate the influence of non-market attributes (like proximity to parks or landfills) on the price of goods (such as houses).
- 2. Stated preference methods. In principle, stated preference methods (including contingent valuation and choice modeling) can be used to estimate virtually all types of values, but their validity is more controversial. These survey-based methods typically impute values by asking people to make choices between hypothetical policy options, in which better environmental outcomes are associated with higher costs (such as higher taxes and the loss of economic uses of environmental resources).

Both of these valuation methods embody a number of practical and scientific challenges, including for example costs and extracting the kind of information actually wanted from a survey process. Given these challenges, the concept of **benefit transfer** — of deriving benefit values from previously completed studies and applying them in new but similar contexts — has substantial appeal to public agencies faced with the need to complete a diverse range of benefit cost studies. However, this approach comes with challenges of its own, including finding case studies that align with the local policy under consideration.

Recommendations

This study's findings suggest the following implications for ADEQ's proposed economic modeling process:

- Based on costs and other practical considerations, ADEQ should focus on the benefit transfer approach (i.e., secondary use of previously published studies) whenever possible, including consideration of investing in primary research to address specialized topics
- Given the complexities involved, full implementation of recommended modeling processes may in some cases require technical specialists/expertise (e.g., university-based economists)
- ADEQ's economic analysis model should explicitly incorporate opportunities for stakeholder input to supplement and validate the values generated by the model
- ADEQ should recognize and acknowledge the various limitations associated with these types of
 analyses, while still attempting to provide meaningful BCA estimates. In this regard, all benefit
 and cost estimates should be characterized as the as "best available" but not definitive, and
 economic benefit/cost modeling for water quality in Arizona can be expected to be an ongoing
 process for the foreseeable future, due to the considerations addressed in this report.



III. Modeling Elements

This section is a compilation of the consultants' initial scoping of content to be considered within the benefit/cost modeling framework. It is based primarily on interpretation of ADEQ material from various documents, webpages, and other sources, organized topically as shown below, and not necessarily an exhaustive treatment of these various topics. The categorizations are intended to help formulate ways of thinking about modeling issues and the structure of analysis frameworks. In this sense, the "elements" are simply different dimensions of the overall benefit/cost modeling assignment.

These elements are listed in the two sections below, the first showing major category headings and the second the subcategories within these major groups. The element topics are wide-ranging, from administrative to scientific influences.

A "working version" of the list of modeling elements shown in this chapter is shown in Appendix A. The appendix list is annotated with questions and commentary intended to help guide the benefit/cost modeling process.

Major category headings

Surface Water Protection (SWP) programs

Benefit categories

Cost categories of particular note by ADEQ

Affected Parties, by user type

Affected Parties, by government agency/political subdivision and private business type

Topical categories for Standards applied to contaminants

Categories and Subcategories

Surface Water Protection (SWP) programs

AZPDES permitting program (section 402)

Water quality assessment (section 305b) and impaired water listing (303d)

Total maximum daily load (TMDL) program for impaired waters

- Permitted effluent limits
- Restoration efforts

Benefit Categories

Household use

- Drinking
- Cooking
- Bathing (full body contact)

Recreational

- Swimming (full body contact)
- Fishing
- Boating
- Other water-based recreation

Environmental

- Aquatic and wildlife
- Fish consumption

Industrial/institutional

- Reduced water treatment costs
- Avoidance of costs associated with development alternative water sources
- Industrial use (e.g., reduced sediment wear on machinery)
- Clarification/correction of errors in regulations (streamlines/reduces compliance costs)

Navigation

<u>Cost categories of note</u> (other cost categories would be included within the modeling process, including capital costs for water treatment facilities, user charges, and the like)

Monitoring costs for permit holders

Increased utility rates (for consumers)

- Cleanup actions
- Reporting costs for "variance applications"

Affected Parties, by user type

Agriculture (irrigation and livestock watering)

Fish hatcheries

Power plants

Truck stops

Marinas

Water Quality Assurance Revolving Fund (WQARF) remediation projects

Affected Parties, by government agency/political subdivision and private business type

State and local government agencies

ADEQ

Agencies operating under individual or general AZPDES permits

Political subdivisions

Political subdivisions generally, public WWTPs, POTWs, public laboratories

Non-WWTP government entities operating under AZPDES individual permits

Non-WWTP government entities operating under AZPDES general permits

Privately-Owned Businesses

Private entities operating under general permits

Private, non-WWTP individual permit holders

Private WWTPs

Private laboratories

Topical categories related to Standards

Salinity standards

Nutrient standards

Site-specific standards (proposed by individual regulated users/businesses) – limited use to date

Schedules of compliance (now three years)

Ephemeral waters versus effluent dependent waters

Specific chemicals and chemical compounds, metals, etc.

IV. Illustrative Modeling Framework

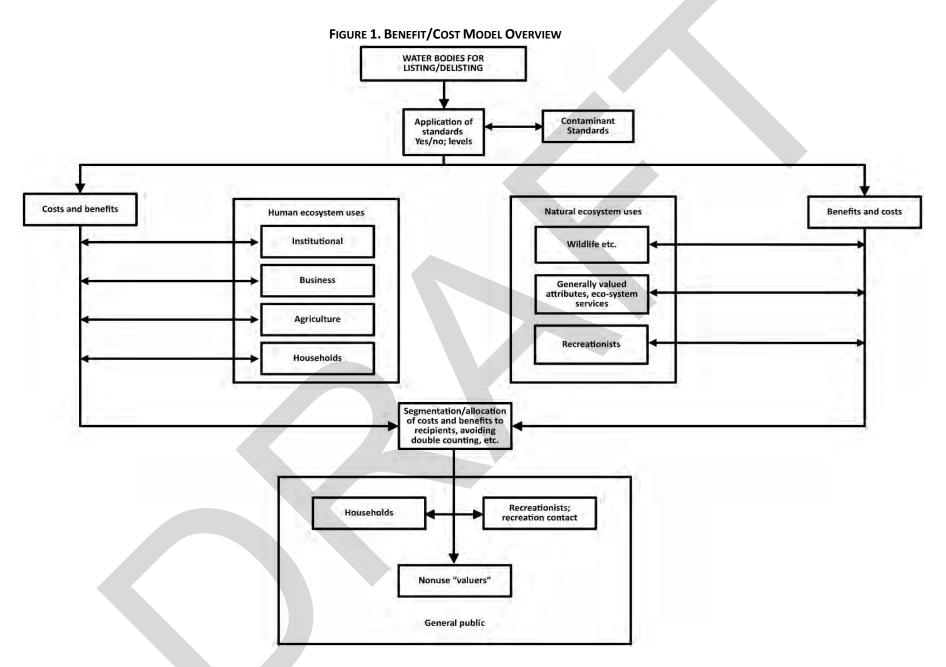
The three diagrams summarizing various aspects of an economic benefit/cost modeling framework in this chapter represent a distillation of some of the key topics listed in the preceding chapter. Figure 1 is a generalized flowchart of how the benefits and costs related to changes in water quality standards would be generated. In the diagram, decisions are made regarding the adoption of standards levels for different contaminants, and these are applied to uses, as relevant for the contaminant/standard level, within the two overall categories of Human Ecosystems and Natural Ecosystems. The three to four uses within each of these two broad categories will sometimes each have different water quality standards that apply to them as well as different cost and benefit implications. (The Human Ecosystem diagram refers to "costs and benefits," and the Natural Ecosystem, "benefits and costs," with the different order loosely reflecting the likely emphasis within the analytical procedures to be carried out).¹

From the standpoint of the general public, gross benefit and cost numbers would then need to be segmented and allocated according to various categories of beneficiaries/payees, with the understanding that different "publics" have different factors associated with their potential gains and losses, as described below. Within this kind of framework, analysts must take care to avoid double counting due to the possibility of overlapping beneficiaries/payees.

- Households benefit from having access to water that meets appropriate quality standards, for a variety of functions
- Recreationists benefit by being able to make use of water that could otherwise be closed to fishing or to partial or full body contact, or be less desirable from the standpoint of sensory experience
- At least some non-users may nevertheless value water that meets usable standards, just, for example, from knowing that it exists in water bodies of which they are aware

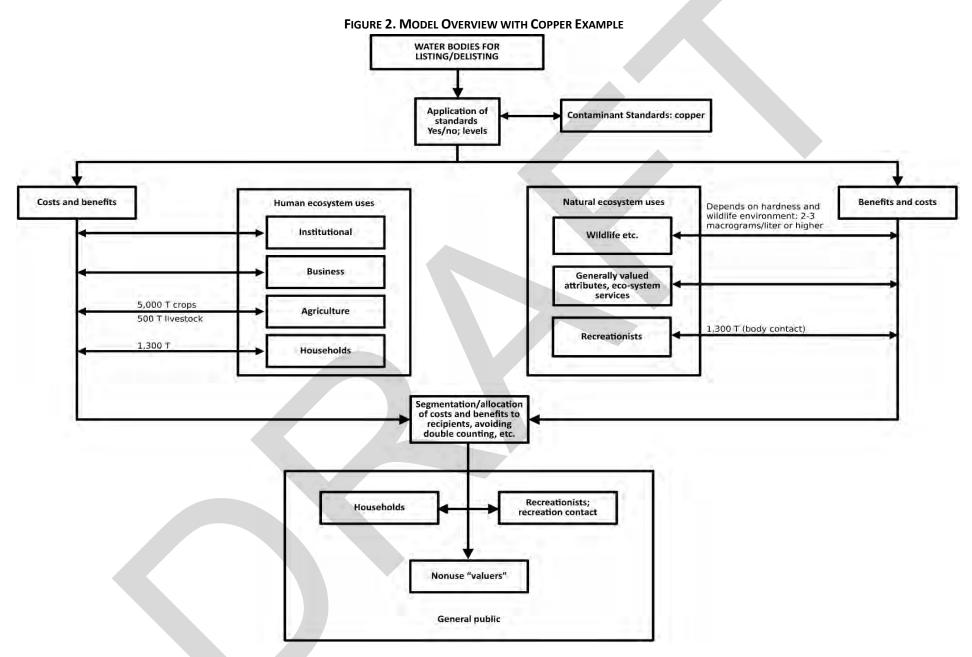
Figure 2 duplicates the diagram in Figure 1 for the purpose of illustrating some of the key implications of how the variation in standards for a specific contaminant, copper, would apply to different uses, including for example the fact that standards can vary according to sub-environments in which some aquatic species exist.

¹ Generally, in this document, benefits and costs are referred to as "benefits/costs," reflecting the arithmetic reality that a "benefit/cost ratio" would ultimately be produced as one indicator of project justification, and which would be calculated as a benefit total divided by a cost total.



Assessment of Potential Approaches to Economic Benefit/Cost Analysis of Arizona Water Quality Policy

McClure Consulting LLC, with The Natelson Dale Group, Inc.



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Figure 3 represents an expanded view of the general flowchart of Figure 1, and provides additional insight into the procedural steps that would apply to individual benefit and cost components, for each combination of:

- Use Case (and the diagram shows as an example the use being a public wastewater treatment plant);
- · Contaminant; and
- Standards applied to that contaminant (also noting that an existing standard level, proposed new standard, and incremental change in the standard can all be relevant considerations within the model, along with the fact that standards can differ for different uses as noted above).

The cost side of the diagram, on the left, is intended to be read from right to left, and the benefit side, to the right, reads left to right. The two outermost columns represent essentially the same thing, with the link between the two just emphasizing that the two sets of figures must be reconciled, for example in terms of the present value of a set of annual benefits or costs, the units of measure represented by the value numbers, and other details. The column headings are additionally described below, for each of the two components of costs and benefits.

FIGURE 3 COLUMN HEADINGS

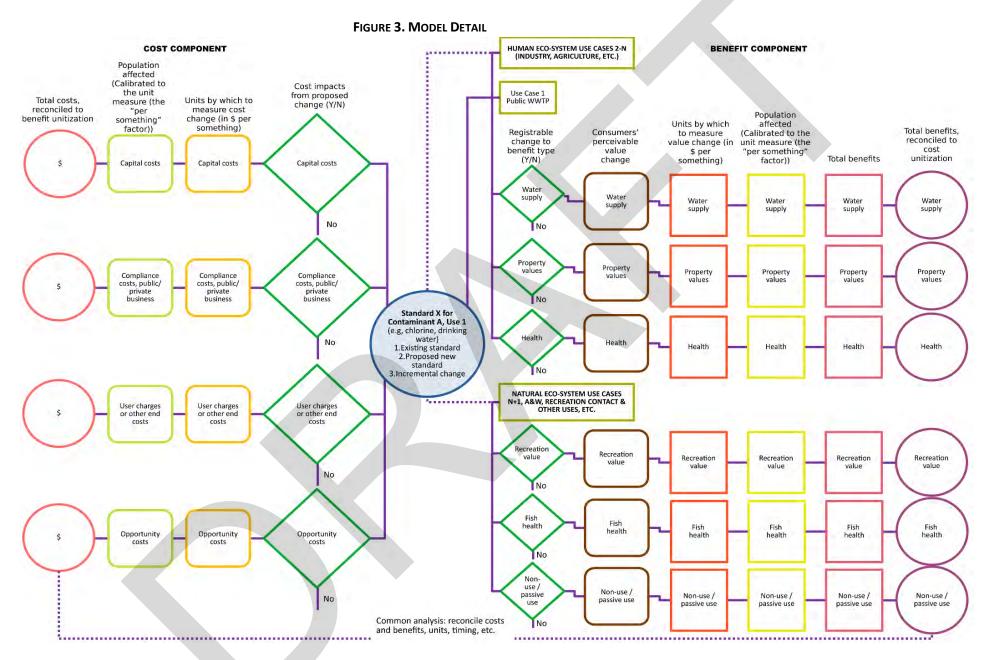
Cost and Benefit Column Headings	Notes
COST COMPONENTS	
Cost impacts from proposed change	Simple decision on whether or not cost impacts
(Yes/No)	apply in this particular case
Units by which to measure cost change (in \$ per something)	Cost figures might be available in dollars per acre, per water body, per installation of some sort, etc., or may be translatable from data available to some other standard unit of measure
Population affected (calibrated to the unit measure (the "per something" factor))	What is the population affected by a change in a contaminant standard, which is likely to vary by different use types, and would generally have to be reconciled to some unit of measure
Total costs, reconciled to benefit unitization	Figures for costs and benefits must be directly comparable, and units, over some extended time periods (If applicable), etc.
BENEFIT COMPONENTS	
Registrable change to benefit type (Y/N)	Does the change in standard result in a perceivable change in some condition, recognizable through the senses or otherwise communicated
Consumers' perceivable value change	How is a change in value to be reflected in terms of a dollar value to a user, either directly, in terms of price change for example, or indirectly through such things as expenditures on recreational activities
Units by which to measure value change (in \$ per something)	Benefit figures can vary by units just as cost figures, described above

Cost and Benefit Column Headings	Notes
Population affected (calibrated to the unit measure (the "per something" factor))	Different affected populations are likely to have to be estimated by different means, and may overlap among user categories
Total benefits	ū ū
Total benefits, reconciled to cost unitization	Reconciliation is needed, just as noted in "costs" above

Figure 3 shows typical benefit categories associated separately with the two ecosystems of Human and Natural. Cost categories could be generally applicable to all of the benefit categories.

Note that Figures 1 to 3 are provided to ADEQ as images in a separate deliverable, so they may be used in a larger format if desired. Source of figures is McClure Consulting LLC/TNDG.





Assessment of Potential Approaches to Economic Benefit/Cost Analysis of Arizona Water Quality Policy

McClure Consulting LLC, with The Natelson Dale Group, Inc.

V. Overview of Economic Valuation Methodologies for Water Quality Benefits

The examination of methodologies in this chapter focuses on what tends to be the most challenging subject area from the standpoint of both methodological integrity and acceptability — estimating benefits to recreationists, especially, and in some cases "passive" users or non-users who value good water quality in an indirect way. However, there are numerous other methodological categories that need to be addressed within a complete benefit/cost modeling process, some of which are fairly straightforward and others that also involve complex investigations and formulation, including for example:

- Differences in costs to treat water for contaminants at different standards, within different types and scales of facilities
- If a benefit of water treatment is to avoid or forestall obtaining additional water supplies, what is the appropriate basis for estimating costs of such supplies?
- Improved water quality could lower the cost of industrial or agricultural production in a number of ways, not all of which would necessarily be obvious and/or readily calculable (for example, reduced wear on industrial machinery because of lowered turbidity)
- Differences in water quality levels could affect the economic development prospects (and population growth prospects as well, which can be somewhat independent of economic growth) of places; but can such effects be meaningfully captured?

Benefit/cost analysis (BCA) for environmental protection policies is inherently challenging due to the "non-market" nature of many environmental resources. Whereas the *costs* of environmental regulation tend to be readily quantifiable (or at least reasonably estimable) by the affected parties, the *benefits* often relate to "goods and services" (e.g., clean recreational water and healthy fish populations) that are not traded in markets and therefore are not subject to market-based pricing.

Some environmental goods, such as edible fish, are traded in markets where their value can be directly observed. However, a non-market good or service is something that is not bought or sold directly (or for which only a nominal admission price is charged – not reflecting the good's full value to society). Therefore, a non-market good does not have an observable monetary value. Examples of non-market goods include recreational fishing, wildlife viewing, and other water-based recreation.

Since the economic value of non-market environmental resources – how much the public would be willing to pay for them (or to improve their quality) – is not revealed in market prices, academic economists have developed a variety of methods for valuing non-market goods. In practice these valuation techniques have been applied in a wide range of circumstances (e.g., in litigation involving damages to environmental resources) where it is essential to quantify resource values in dollar terms. Although the validity of these valuation methodologies is recognized in academic, legal and policymaking contexts, in practice they are often costly to correctly apply, are difficult for the public to understand, and are subject to wide variations in resulting benefit values (unlike market values which tend to converge around fairly tight price ranges).

Due to these challenges, benefit/cost studies for environmental goods often focus mostly on costs and address benefits (if at all) in superficial, incomplete or non-quantitative ways. Without robust valuation estimates for non-market benefits, these resources may be implicitly undervalued and decisions regarding their use and stewardship may not accurately reflect their true value to society.

The proposed economic modelling framework for ADEQ includes recommendations for improving ADEQ's procedures for quantifying various benefits associated with water quality protection programs. The narrative below provides a brief overview of the valuation techniques typically used for non-market environmental resources and discusses their potential applicability to ADEQ's economic modeling efforts. Whereas the limitations of these techniques are acknowledged (and more fully discussed in the next chapter of this report), the recommended approach for ADEQ is intended to balance these potential limitations with the significant advantages of a BCA model that allows for dollar-value comparisons of benefits and costs.

Valuation Methods²

As detailed below, there are two main types of non-market valuation methods:

- 1. Revealed preference methods; and
- 2. Stated preference methods.

In addition, *benefit transfer* is essentially a "secondary research" technique that can be used to apply existing value estimates (from previously published studies) to new contexts.

Revealed preference methods. Revealed preference methods use observations of purchasing decisions and other behavior to estimate non-market values. For example:

- The <u>travel-cost method</u> uses recreation expenditures and travel time to impute the value people place on visiting a specific site (such as a national park); and
- The <u>hedonic pricing method</u> attempts to isolate the influence of non-market attributes (like proximity to parks or landfills) on the price of goods (such as houses).

The ability of revealed preference methods to produce valid non-market value estimates is widely accepted. However, there are many circumstances where these methods cannot provide the estimates needed for environmental policy analysis. Because they rely on values leaving a "behavioral trace," they cannot be used to estimate so called "non-use" values (for example, the value people derive from the mere existence of a species or ecosystem – separate from any intended actual "use" of these resources). The methods also focus on what has already happened, which can limit their usefulness for valuing prospective changes. For example, the travel-cost method might be able to provide an estimate of the recreational value of an area of native forest, but not the change in value from a proposed program to eradicate pest plants and animals from the forest. More generally, the main limitation lies in the lack (or inadequacy) of data sets that contain traces of non-market values for environmental outcomes.

² The summary in this section has been extracted/paraphrased from a more detailed discussion in a working paper titled "Environmental Policy Analysis: A Guide to Non-Market Valuation" published in January 2014 by the Australian Government Productivity Commission.

Stated preference methods. In principle, stated preference methods (including contingent valuation and choice modeling) can be used to estimate virtually all types of values, but their validity is more controversial. These survey-based methods typically impute values by asking people to make choices between hypothetical policy options, in which better environmental outcomes are associated with higher costs (such as higher taxes and the loss of economic uses of environmental resources).

Ever since contingent valuation was used to estimate damages from the Exxon Valdez oil spill in Alaska in the early 1990s, there has been a lively and sometimes heated debate about the validity of stated preference methods among economists and others. More recent evidence suggests that stated preference estimates:

- Are often broadly similar to revealed preference estimates;
- Have been found to be consistent with binding referendums on environmental policies; and
- Often conform to predictions derived from economic theory (while there are exceptions, these
 can frequently be explained by either poor survey design or behavioral influences that can also
 affect market transactions).

These findings suggest that stated preference methods are able to provide valid estimates of non-market values for use in environmental policy analysis. However, there are many different elements that practitioners need to get right for stated preference surveys to produce meaningful results. One of the most important is that participants should be made to feel that their responses could influence outcomes that they care about (for example, that they would actually be required to pay the amount they state in order to achieve an improved environmental outcome – rather than just commenting on it conceptually). Much of the debate about stated preference surveys has been about their hypothetical nature, but there is now broad agreement that they can be designed to appear consequential and not purely hypothetical.

It is also crucial that surveys provide clear and specific information about the environmental outcomes that people are being asked to value. Outcomes should be expressed in terms of endpoints that people directly value and should align with the expected outcomes from proposed policies. People will often answer survey questions even if they do not understand or approve of the questions and so there is an important role for follow-up questions that can be used to filter out unreliable responses. Knowledge about how to improve stated preference estimates has increased over the last 20 years and useful new tools have been developed.

How well stated preference methods perform can depend on how familiar respondents are with the environmental assets in question. For example, people surveyed at a recreation site about their willingness to pay to visit are likely to be able to provide well-informed answers based on their knowledge and feelings about the site, and possibly also knowledge about substitute sites they might prefer if the cost of visiting changed. By contrast, when people are asked about environmental assets that are relatively unfamiliar to them (and which they may never visit) they rely more on the information presented to them and may have to construct their preferences during the survey. While this can be done, insights from behavioral economics suggest that people are more likely to be prone to cognitive biases in such low-experience situations. For example, the focus of a survey on a particular

environmental asset may cause people to elevate its significance relative to a situation where it was considered as one asset among many.

Two conclusions follow from the above observations about stated preference (contingent valuation) studies. First, survey design, including the information provided to respondents and techniques for weeding out unreliable answers, is of particular importance when valuing less familiar (or more complex) outcomes. Second, value estimates may be less accurate for unfamiliar outcomes, even with careful attention to survey design. Such problems are more likely to occur for non-use values and so stated preference methods may be less effective in estimating the very type of value for which other valuation methods cannot be used.

Benefit transfer. Given the practical challenges (and substantial primary research costs) associated with the revealed preference and stated preference valuation techniques described above, the concept of **benefit transfer** – of deriving benefit values from previously completed studies and applying them in new but similar contexts – has substantial appeal to public agencies faced with the need to complete a diverse range of benefit cost studies.

While attractive from a cost perspective, the evidence suggests that transferring value estimates from one site to another is likely to be very imprecise (and possibly misleading) unless there is a high degree of similarity between the "study" and "policy" contexts (in terms of the environmental features, policy outcomes and population characteristics). These seemingly obvious cautions are often not observed. However, if even a very imprecise value estimate is potentially of use, benefit transfer may be worth considering even when the available primary studies are less than ideal.

Summary: Key Points on Valuation of Non-Market Environmental Resources

- Government policies aimed at generating environmental benefits almost always impose costs on affected agencies, industries and the public. Weighing these trade-offs is challenging, in part because environmental benefits are difficult to value, particularly those that are not reflected in market prices (so called 'non-market' values).
- There are several non-market valuation methods that can be used to evaluate such trade-offs.
 The two main types of non-market valuation methods are revealed preference and stated preference:
 - The validity of revealed preference methods is widely accepted, but there are many circumstances where they cannot provide the estimates needed for environmental policy analysis
 - Stated preference methods can be used to estimate virtually all types of environmental values, but their validity is more controversial
- The evidence suggests that stated preference methods are able to provide valid estimates for use in environmental policy analysis. However:
 - There are many elements that practitioners need to get right to produce meaningful results

- Value estimates are likely to be less reliable when respondents are asked about environmental assets that are especially complex or relatively unfamiliar to them
- Benefit transfer involves applying available value estimates to new contexts. Its accuracy is likely
 to be low unless the primary studies are of high quality and relate to similar environmental and
 policy contexts. These seemingly obvious cautions are often not observed. However, there are
 many policymaking circumstances in which even imprecise value estimates are useful (and
 preferable to ignoring the valued benefits altogether).
- Because non-market valuation methods can generally provide objective estimates of the value that the community places on environmental outcomes, they offer advantages over other approaches to factoring these outcomes into policy analysis.
- The case for using non-market valuation varies according to circumstances. It is likely to be strongest where the financial or environmental stakes are high and there is potential for environmental outcomes to influence policy decisions.
- Where non-market valuation estimates are made, they should generally be included in a benefit-cost analysis. Sensitivity analysis should be provided, as well as descriptive information about the environmental outcomes of the proposed policy.



IV. Complexities, Limitations and Pitfalls of Environmental Benefit/Cost Analysis

As described in the preceding chapter, benefit/cost analyses for environmental resources are subject to a number of unique challenges, including the following:

- The costs of implementing environmental protection policies tend to be more readily quantified than the benefits, in part because the costs are typically experienced as direct "out of pocket" expenses by affected parties who are often in a position (in terms of access to proprietary business data, etc.) to accurately estimate these cost impacts. These known (or reasonably knowable) costs include: administrative expenses to agencies charged with implementing and enforcing new regulations; mandated capital expenditures (for new equipment, etc.) and ongoing compliance costs for regulated industries; potential loss of business revenue to regulated businesses (e.g., when regulatory compliance results in less competitive operations compared to firms in regions not subject to comparable regulations); and price increases to consumers (for goods and services affected by environmental regulations).
- In contrast to the more readily estimable cost impacts of environmental regulations, the
 economic valuation of environmental benefits is problematic due to the non-market (i.e.,
 unpriced) nature of many environmental resources.
- Due to the above factors, benefit/cost studies for environmental goods often focus mostly on costs and address benefits (if at all) in superficial, incomplete or non-quantitative ways. In ADEQ's case, previous benefit/cost studies have tended to default to very broad dollar ranges rather than specific estimates. In particular, previous ADEQ studies have defined benefit and cost impacts in terms of the following categories:

Minimal	Moderate	Substantial	Significant
\$10,000 or less	\$10,001 to \$1,000,000	\$1,000,001 or more	Cost/Burden cannot be
			calculated, but the Department
			expects it to be important to
			the analysis.

While this range-based approach is an important first step and superior to studies which entirely ignore the benefit side of the BCA equation, the very wide dollar ranges (applied to both benefits and costs) can result in studies which are inconclusive in terms of being able to predict that a proposed policy will have a net positive or net negative economic impact. For example, a policy expected to result in "moderate" benefits and "moderate" costs might, at face value, be assumed to have a neutral economic impact. In reality, if the project's benefits were in the low end of the "moderate" range (\$10,001) and costs are in the high end of range (\$1,000,000) – or vice versa – the policy's net economic impacts would be far from neutral.

 The two primary research methods that have been developed to address valuation of nonmarket environmental benefits are each subject to limitations and shortcomings (as noted in the preceding chapter):

- Revealed preference methods considered more accurate (because based on actual consumer choices), but there are many circumstances where they cannot provide the estimates needed for environmental policy analysis.
- Stated preference methods (e.g., contingent valuation surveys) can be used to estimate virtually all types of environmental values, but their accuracy is contestable and highly sensitive to the quality of the research program.

In addition to the underlying technical constraints of these methods, primary research processes tend to be costly and time-consuming to implement.

Complexities of Applying Benefit Transfer Method

Due to the costs and other practical constraints of primary research, the benefit transfer method (i.e., extracting usable values from previously published studies) is likely to be the most feasible and flexible approach to developing economic benefit values for the ADEQ BCA process. However, the benefit transfer method involves certain complexities in its own right:

- Alignment of available studies with the context/intent of a proposed ADEQ policy. The
 universe of previous studies relevant to a particular issue (e.g., a specific water quality standard)
 is likely to be limited (or nonexistent); also the benefit categories addressed by a particular
 study may not include the full range of benefits that ADEQ intends to address.
- Quality of previous studies. In addition to being limited in number, the quality of previous studies may limit their usefulness for ADEQ's purposes. Data/values derived from poorly conducted studies will, if not appropriated adjusted, result in less credible conclusions for secondary studies relying on these data.
- **Determining relevance of previous studies**. Each previous study that is a "candidate" for use in a benefit transfer analysis needs to be carefully reviewed with respect to a range of factors influencing its relevance to the policy under consideration: comparability of geographic location (including demographic and other characteristics); scope of the analysis (i.e., benefit categories included), date (old studies can be less relevant/useful), similarity of policy settings, and similarity of the environmental resources being valued.
- Potential use of econometric (regression) analysis. Although part of the appeal of the benefit
 transfer approach is that it is in theory simple to apply, the most credible benefit transfer
 studies utilize sophisticated regression analysis (rather than simply averaging unitized benefit
 values) to adapt the values from previous studies for purposes of evaluating a new proposed
 policy. While this is a plus for accuracy, this type of econometric analysis typically involves the
 expertise of academic economists specialized in environmental and resource economics.

General Complexities of Environmental Benefit/cost Analysis

In addition to the specific challenges associated with benefit transfer studies, environmental BCA's in general are subject to the following key complexities (which can undermine the credibility of conclusions if not properly addressed):

- The need to distinguish between the total value of a resource versus the marginal value of an incremental change in that resource. It is not uncommon for a study to focus on the total value to society of particular environmental resource in a particular region (e.g., the total value of protecting recreational waters in a particular state or county). This information is useful for benchmarking purposes, but it has a somewhat different purpose from the types of questions that ADEQ is likely to be addressing as part of its economic modeling process (which is likely to be focused incremental changes resulting from a specific change in a specific water quality standard). For example, instead of calculating the total value of protecting all lakes in a county, ADEQ is more likely to be asking the question, "How much would the recreational value of the lakes in this county increase if there is a change in the standard for a specific contaminant?"
- Attribution of marginal benefits to a specific proposed policy change. In addition to the need to distinguish between the total value of an asset and marginal changes in that value, it is also necessary to make the connection between a physical change (i.e., a change in environmental standards) and the affect the physical change has on the way the public perceives the value of the resource. This need to establish a "nexus" between physical and economic benefits will ideally be determined based on collaboration between environmental scientists and economists, allowing for direct attribution of an economic benefit to a specific policy proposal.
- Focusing of analysis on specific policy variables. It is foreseeable that ADEQ will find it useful for future economic impact studies to focus on the potential impacts of an individual policy variable (e.g., a proposed change in a single standard for a specific contaminant). This makes sense from a policy standpoint but does not necessarily align with the way that the public/consumers think about the value of water quality. For example, rather than thinking of a single water quality standard in insolation, consumers are likely to think of "good" or "safe" drinking water as a "package" based on multiple standards and qualities. In this regard, many economic valuation studies value overall water quality in terms of a good-fair-poor scale, rather than attempting to calculate a change in value from improving an individual standard (such as, for example, copper). As such, there are likely to be challenges finding previous studies (for applying the benefit transfer approach) to address the full range of standards/issues that ADEQ might need to address.

Conceptual issues include the fact that there are "camps" of proponents of alternate ways to think about environmental benefits and costs. These groups tend to frame the issue broadly, for example using the term "ecosystem services" to help emphasize the comprehensive nature of this topic.

Proponents of different concepts also invent new terminology. For example, "nature-based solutions," and "nature's contributions to people." As the authors of this cited work point out, these concept titles,

³ Hayley Stevenson, Graeme Auld, Jen Iris Allan, Lorraine Elliott, and James Meadowcroft. The Practical Fit of Concepts: Ecosystem Services and the Value of Nature. *Global Environmental Politics* 21:2, May 2021,

with their different shades of meaning around the same theme, can help define a theoretical concept while not necessarily articulating a workable concept in terms of, for example, translating specific conceptual conditions to dollar values. The international nature of some of these groups adds to the complexity. At the same time, Stevenson et al. argue that "Ecosystem Services is a complex concept that reveals interactions between distinct elements in the natural world and connects humans and nature by stressing the functions that emerge from these interactions. Ecosystem services is also a technical concept that grounds environmental decisions in financial and economic modes of reasoning, often including, though not always or necessarily, monetary valuation" (page 4, as numbered).

Another ongoing conceptual issue is that much of the output of economic literature is devoted to how prior studies and concepts fall short, and how they can be refined. Analysts working in the "real world" must thus weigh expediency and understandability against technical rigor. Analytical systems, if relatively simple, can be understood by lay audiences. The more complex and obscure a system is, the harder it is to understand and probably also the more demanding its data requirements; so that methods can outpace data availability and timeliness.

These challenges can be addressed to some extent through the following:

- 1. Base analysis models on the least vulnerable/controversial methods that are still credible.
- 2. Structure models to be open-ended where possible, recognizing where changes might come from and in what form, as well as accommodating changes in values.
- 3. Set up a system for tracking analytical trends and their apparent relevance to the specific topic at hand.

The United Nations is also involved in these issues. The document shown below, accessed through the website: https://seea.un.org/ecosystem-accounting, is noted on that site as "prepared under the guidance of the SEEA Experimental Ecosystem Accounting Technical Committee under the auspices of the UN Committee of Experts on Environmental-Economic Accounting (UNCEEA). It is part of the work on the Revision of the System of Environmental-Economic Accounting 2012—Experimental Ecosystem Accounting being coordinated by the United Nations Statistics Division."

System of Environmental-Economic Accounting—Ecosystem Accounting (SEEA EA). Final Draft, Version 5 February 2021

The document is described as "a spatially-based, integrated statistical framework for organizing biophysical information about ecosystems, measuring ecosystem services, tracking changes in ecosystem extent and condition, valuing ecosystem services and assets and linking this information to measures of economic and human activity. It was developed to respond to a range of policy demands and challenges with a focus on making visible the contributions of nature to the economy and people."

Potentially Relevant Bibliography

The consulting team produced a "working database" consisting of annotated bibliographic material that is potentially useful to the ultimate formulation of the benefit/cost models. This material is contained in

https://doi.org/10.1162/glep a 00587. Massachusetts Institute of Technology. Downloaded from http://direct.mit.edu/glep/article-pdf/21/2/3/1911391/glep_a_00587.pdf on 10 June 2021.

Appendix B. The entries in the Appendix are selections from the consultants' files of over 150 documents that have been partially reviewed and annotated in a separate system. The selected documents summarized are not necessarily an exhaustive extraction of all the most relevant cases from those files, but are generally representative of the kind of material compiled. The database is also in preliminary form in terms of some of its content, with placeholders for additional input as needed within an ongoing modeling process.



VII. Recommended Implementation Steps

Discussions in the preceding chapters have the following implications for ADEQ's proposed economic modeling process:

- Based on costs and other practical considerations, ADEQ should focus on the benefit transfer approach (i.e., secondary use of previously published studies) whenever possible. In some cases (when there are limited options in terms of previously published research), ADEQ may find it necessary to invest in primary research to address specialized topics (i.e., specific types of standards not adequately addressed in other research).
- Economic analyses for environmental issues are inherently complex, and there are also complexities in establishing the nexus between physical/environmental changes and incremental economic benefits. Based on these conditions, full implementation of the recommended modeling process may in some cases require technical specialists/expertise (e.g., university-based economists). This conclusion would apply even for the relatively "simple" benefit transfer approach which in some cases involves sophisticated regression analysis in order to render the factors derived from other studies usable for purposes of evaluating other proposed policies (in other contexts, timeframes, etc.).
- ADEQ's economic analysis model should explicitly incorporate opportunities for stakeholder input to supplement and validate the values generated by the model. Stakeholder input is likely to be especially useful in estimating cost impacts to industries (and would appear to be logistically practical given the relatively small "universe" of impacted industries/firms by particular policies).
- ADEQ should recognize and acknowledge the various limitations associated with this type of
 analysis, while still attempting to provide meaningful BCA estimates. In this regard, all benefit
 and cost estimates should be characterized as the as "best available" but not definitive.

Finally, economic benefit/cost modeling for water quality in Arizona will be an ongoing process for the foreseeable future, due to the following, among other considerations:

- Evolving policies on waters to be protected, levels of protection desired and considered implementable, priority of users to be protected, and similar considerations, based on both state and federal guidance as well as input from various users throughout the state
- The need for and availability of additional technical data on effects of contaminants and related standards, the interrelationship among contaminants and between contaminants and other environmental conditions, hydrologic conditions, and other scientific/technical considerations
- Water availability by source and demands on water from different users and from growth in general
- The evolving science of benefit/cost modeling, some aspects of which are summarized in this document

With the understanding and acceptance of such an ongoing process, a phased approach to benefit/cost modeling can be designed and undertaken. Phasing concepts would take into account the following considerations, at a minimum:

- 1. How each cost and benefit measure varies according to its degree of "acceptability" as both a general concept and according to the relative believability of estimates generated
- 2. The segmentation of entities affected by water quality decisions into the broad categories of Human and Natural, and the implications for economic modeling as it would apply to those two categories into specific entities within those categories
- 3. The user/affected population that would ultimately bear costs or receive benefits
- 4. The relative levels of effort involved in generating different types of benefit/cost estimates, which can vary widely, and the "payoff" associated with each type of estimate in terms of acceptability (see Consideration #1 above)
- 5. The relative magnitude of cost and of benefit figures, especially, that can be generated through a particular analysis method, which if considered in concert with the factors mentioned in Item #1 in this list could potentially lead to generation of a "lower bound" of benefit amount that is achievable, understandable, and also sufficient to add meaningful clarity to the weighing of benefits against costs for selecting water quality actions



Appendix A. Table of Benefit/Cost Modeling Elements and Related Questions and Commentary

Designing an economic benefit/cost model for water quality involves consideration of a number of elements. A "working version" of a list of modeling elements, generated by the consultants primarily from ADEQ material, is shown in this appendix, which includes questions and commentary related to the list intended to help guide the benefit/cost modeling process. The elements listed are intended to reflect primarily those of interest to ADEQ, based on previous documents and other agency content.



Excerpts (pg. 59-79) from 2019 NFRM for R18-11 WQS AND 2016 NFRM FOR R18-11 WQS

Element	Consultant Commentary	Possible doc ref
Surface Water Protection (SWP) programs	Are these program distinctions important from a modeling point of view?	
AZPDES permitting program (section 402)		
Water quality assessment (section 305b) and impaired water listing (303d)		
Total maximum daily load (TMDL) program for impaired waters		
Permitted effluent limits		
 Restoration efforts 		
Benefit Categories (2016)	Can/should each of these be related to specific contaminants, and/or standards related thereto?	
Household use	Perhaps this can be related to a cost forgone for obtaining additional supplies, given that water is basically in short supply throughout the state. We should be able to get enough information to generate a reasonable average	
Drinking		
Cooking		
Bathing ("full body contact")		
Recreational	Figures in Audubon study could potentially be factored to align with specific waters and other details. This category is also addressed in a number of the compiled studies, so a wide range of possible figures is theoretically at hand	
 Swimming (full body contact) 		
• Fishing		
Boating		
 Other water-based recreation 		
Environmental		
Aquatic and wildlife	This should also be addressable in some way through numerous willingness-to-pay studies we have compiled	

Element	Consultant Commentary	Possible doc ref
• Fish consumption	While this is potentially a health issue, it seems most likely and defensible to think of this in terms of closures of waters, resulting in recreational benefits forgone, so could overlap with the recreational category	
Industrial/institutional		
Reduced water treatment costs	Relevant data could be difficult to obtain, especially getting into details of particular contaminants and fractional changes thereto	
 Avoidance of costs associated with development [of] alternative water sources 	Could overlap with the household use category	
 Industrial use (e.g., reduced sediment wear on machinery) 	Would seem to present serious data challenges	
 Clarification/correction of errors in regulations (streamlines/reduces compliance costs) 	Reasonable estimates could probably be developed in consultation with ADEQ	
Navigation (2019)		
Cost categories specifically mentioned		
Monitoring costs for permit holders	Reasonable estimates could probably be developed in consultation with ADEQ	
Increased utility rates (for consumers)	Reasonable estimates could probably be developed in consultation with ADEQ	
 Cleanup actions (2016) 		
 Reporting costs for "variance applications" (2016) 		
Affected Parties, by user type		
Agriculture (irrigation and livestock watering)	Might be relatable to costs forgone to secure additional supplies, in this case perhaps groundwater pumping costs	
Fish hatcheries	Overlap with recreational category	
Power plants	Data challenge	
Truck stops	Relatable to alternative supply costs?	
Marinas	Overlap with recreational category	

Element	Consultant Commentary	Possible doc ref
Water Quality Assurance Revolving Fund (WQARF) remediation projects	Reasonable estimates could probably be developed in consultation with ADEQ	
Affected Parties. by government agency/political subdivision and private business type		
Based on the information above, ADEQ has identified the following list of affected persons:		
State and local government agencies		
ADEQ	Reasonable estimates could probably be developed in consultation with ADEQ	
Agencies operating under individual or general AZPDES permits	(see above)	
Political subdivisions		
Political subdivisions generally, public WWTPs, POTWs, public laboratories	(see above, for Reduced water treatment costs)	
Non-WWTP government entities operating under AZPDES individual permits	Would need close coordination with ADEQ and/or input from specific users	
Non-WWTP government entities operating under AZPDES general permits	Would need close coordination with ADEQ and/or input from specific users	
Privately-Owned Businesses		
Private entities operating under general permits	(see above, for Reduced water treatment costs)	
Private, non-WWTP individual permit holders	Would need close coordination with ADEQ and/or input from specific users	
Private WWTPs	Would need close coordination with ADEQ and/or input from specific users	
Private laboratories	Have some figures from ADEQ, but would require additional input from relevant establishments	
The General Public	In addition to overlap with household and recreational categories, this catchall category could relate to benefits based on willingness-to-pay studies for	

Element	Consultant Commentary	Possible doc ref
	nonuse/passive use or other nonspecific use (studies do not always relate to surface water bodies)	
Types of Standards Mentioned (examples)	All detailed in Title 18; some in Standards Calculator Model as noted	
Salinity standards		
Nutrient standards		
 Site-specific standards (proposed by individual regulated users/businesses) – limited use to date 		
 Schedules of compliance (now three years) 		
Ephemeral waters versus effluent dependent waters	These would seem to be the least relevant waters	

Other categorical considerations

other eategorieal considerations	Consultant Commentary	<u>Possible</u>
		doc ref
Water bodies	Virtually all waters are identified in Title 18, in terms of designated uses they are to	
	serve: 4 categories of aquatic & wildlife, 4 categories of human health, and 2	
	agricultural categories. Facilitates relating water bodies to contaminants/standards	
Guidelines for the State of Arizona	3-tiered approach to control discharges described. Is there some way in which this	
Antidegradation Standard	needs to be integrated into the modeling process?	

Appendix B. Potentially Relevant Bibliography

This appendix is a "working database" consisting of annotated bibliographic material that is potentially useful to the ultimate formulation of benefit/cost models for water quality within ADEQ. These entries are selections from the consultants' files of over 150 documents that have been partially reviewed and annotated in a simpler database (for the consultants' internal use). The selected documents summarized here are not necessarily an exhaustive extraction of all the most relevant cases from those files, but are generally representative of the kind of material compiled. The database is also in preliminary form in terms of some of its content, especially the leftmost columns which are intended to be available as needed as these documents continue to be processed in terms of how they might apply to the modeling exercise.

The Title column includes, in brackets [_] at the end, an index number from the consultant's complete document list.



Potentially Relevant Bibliographic Material

Applies T	o: (any or	all)						
Use	Contam- inant	Benefit Category	Title [our index #]	Subject Focus/Concept (preference surveys, hedonics, benefit transfer, travel costs, etc.)	Year	Page # for \$ ests., other key content	Main Author	Sponsor Agency/ Org.
		Verify relevance ?	CWA and State 404 Program Roadmap [39]	404 proposed 1-time fees for dischargers; reference to other annual etc. fees for other programs	2019	p 15	Pollack	ADEQ
Wet- lands relevant ?			Economic Analysis for the Proposed Redefinition of WOTUS [37]	Wetland benefit transfer values by state	2018	p 101		EPA
			Handbook for Developing Watershed Plans [38]	Downloadable tool for cost-benefit analysis of "buffers" but link is dead and have not found		p 279		
			Implementation Guidelines for the State of Arizona Antidegradation Standard [11]	Arizona antidegradation standard (R18-11-107) is a 3-tiered approach to control discharges. Tier 1 is the minimum protection, provided to all waters of the state. ⁴	no date	See language in Exec. Summary – not sure what might mean for benefit/ cost modeling		ADEQ
			The Economic Contributions of Water- related Outdoor Recreation in Arizona [46]	Recreational benefits for wide range of recreational categories based on travel cost survey; IMPLAN data. Figures could potentially be factored to align with specific waters and other details.	2019	Throughout	Southwick Associates	Audubon
			Ecosystem Services Valuation Database [76] [file: ESVD-version- December-2020 [Excel file]	Summary of monetary values for each [ecosystem] service per biome, one of which is Rivers and Lakes (values in US\$/ha/year, 2020 price levels). Numbers in the cells are averages	2020	Summary values tab		Multiple

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⁴ Discharges must meet this level if: a) the water is classified a tier 1 water because it does not meet fishable/ swimmable goals or b) the water is classified a tier 2 water but has satisfied the requirements of R18-11-107 (C)(1 thru 4). Tier 2 protection is given to all waters that have met the fishable/ swimmable goals and are not Tier 3 water status. All waters of the state (except tier 3) are assumed to be tier 2 waters until a determination of degraded ambient water quality is made. Tier 3 or unique waters are those listed at R18-11-112(E) and are protected against any change in water quality.

Applies T	o: (any or	all)						
Use	Contam- inant	Benefit Category	Title [our index #]	Subject Focus/Concept (preference surveys, hedonics, benefit transfer, travel costs, etc.)	Year	Page # for \$ ests., other key content	Main Author	Sponsor Agency/ Org.
			This is an updated version of a related document in our collection, Global estimates	of the values found for a particular service and biome. Custom reports can also be generated from the entire database by selecting relevant biome and use variables, which we would probably need to do, depending on how we interpret the summary table values. "Valuation methods" tab (and other tabs) explains the concept behind 15 or so methods, which helps interpret what the numbers actually mean.				
			A Meta-Analysis of Ecosystem Services Associated with Wetlands in USFWS National Wildlife Refuges [61]	National wildlife refuge case study - wetlands values. Stated preference study of flood	2013	p. 5		USFWS
			Ontario's Wealth, Canada's Future: The Economic Value of the Greenbelt Plan in Toronto, Canada [78]	Valuation estimates of 7 types of ecosystem services/benefit categories and also by 17 "ecosystem services," using four different types of methods, provided by the Toronto Greenbelt	2005 Can- adian \$	p. 2	Sara Wilson	TEEB
			Banking on Nature The Economic Benefits to Local Communities of National Wildlife Refuge Visitation [63]	Visitor expenditures by non-consumptive, fishing, and hunting uses (sometimes with additional breakdowns), and by residents/ non-residents, for 80 national wildlife refuges; Implan #s too. Corresponding demographic data. A National View section discusses the overall results for the sample refuges and extrapolates them to a nationwide estimate. Appendices provide background detail.	2013 study; 2011 \$	Multiple pages	Erin Carver and James Caudill, Ph.D.	USFWS

Applies T	o: (any or a	all)						
Use	Contam- inant	Benefit Category	Title [our index #]	Subject Focus/Concept (preference surveys, hedonics, benefit transfer, travel costs, etc.)	Year	Page # for \$ ests., other key content	Main Author	Sponsor Agency/ Org.
			Classifying and valuing ecosystem services for urban planning [66]	Categorizes ecosystem services and disservices in urban areas. Describes valuation languages (economic costs, socio-cultural values, resilience) that capture distinct value dimensions of urban ecosystem services. Identifies analytical challenges for valuation. Discusses various ways urban ecosystems services can enhance resilience and quality of life in cities. Identifies a range of economic costs and socio-cultural impacts, by "biophysical accounts," from loss of ecosystem services. Identifies valuation model types.	2013	p. 239	Gómez- Baggethun, D.N. Barton	No mention
			Secondary Methods for Valuing Non-Power Benefits: Benefits Transfer Chapter 6 [originating doc: Economic Analysis for Hydropower Project Relicensing: Guidance and Alternative Methods] ⁵	Although based on changes in water releases below a dam, consumer surplus estimates potentially useful in developing benefits transfer estimates of recreational-use values, for fishing, whitewater rafting other recreational activities, increased instream flow; and non-use values. Willingness to pay per day. Estimates sometimes grouped according to other factors that may influence willingness to pay: species, geographic region, and lake versus river fishing (i.e., habitat).	1998	p. 13 plus tables on five or six other pages, plus wording in text	Robert Black, Bruce McKenney, and Robert Unsworth	USFWS
			2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation [68]	Could potentially be used to calibrate other recreation-benefit estimates	2016	Multiple	None identified	USFWS

⁵ https://www.fws.gov/policy/hydroindex.htm

Applies T	o: (any or	all)						
Use	Contam- inant	Benefit Category	Title [our index #]	Subject Focus/Concept (preference surveys, hedonics, benefit transfer, travel costs, etc.)	Year	Page # for \$ ests., other key content	Main Author	Sponsor Agency/ Org.
			The Economics Associated with Outdoor Recreation, Natural Resources Conservation and Historic Preservation in the United States [72]	Topics: 1. Outdoor recreation – bicycling, camping, fishing, hunting, paddling, snow sports, hiking, climbing and wildlife viewing. Data on participation and expenditures available both regionally and nationwide. Also interpreted in terms of retail sales, taxes, employment, etc., going for total economic impact. 2. Ecosystem services – Climate regulation, waste treatment, water supply, carbon sequestration, nutrient cycling, habitat provision. Value in dollars per acre and estimated acreages (national). 3. Rare and threatened species – Average value by species, from multiple studies. 4. Visits to natural areas – " other visitors may come to these areas for sight-seeing, for family gatherings, for education and for many other values not captured by the category of outdoor recreation." Lump-sum figures for different types of public lands (national). 5. Property values – Property value increases, as percentage of the average home value, for parcels in proximity to different types of parks in Portland, Oregon. Additional other material of less relevance.	2006 to 2010 \$	Multiple	Southwick Associates	The National Fish and Wildlife Founda- tion
			USFWS National Wildlife Refuge Wetland Ecosystem Service Valuation Model - Phase 1B Final Report [74]	1) Point Estimates of Annual WTP per Average Acre by NWR Wetlands and Service, plus total values for multiple refuges. 2) meta-analysis (MA) Forecast Comparison for Water Quality, Annual Value per Acre. Some figures for	2013, mostly2 001 to 2010 \$	p. 47 on	Douglas Patton John Bergstrom	USFWS

Applies 7	o: (any or	all)						
Use	Contam- inant	Benefit Category	Title [our index #]	Subject Focus/Concept (preference surveys, hedonics, benefit transfer, travel costs, etc.)	Year	Page # for \$ ests., other key content	Main Author	Sponsor Agency/ Org.
				recreation value (and for flood control, which seems irrelevant)			Rebecca Moore Alan Covich	
			National Wildlife Refuge Wetland Ecosystem Service Valuation Model, Phase 1 Report [73]	Economic benefits of specific ecosystem services from different types of wetlands. Similar areas etc. to Phase 1B report cited above, and addresses a wider range of benefits: Storm protection, Water quality, Commercial fish habitat, and Carbon storage (point transfer approach, others are meta-analysis benefit transfer). Gross and per-acre values.	2012, 2010 \$	In executive summary and starting on page 81	[same as above]	USFWS
			Natural Capital Valuation in the Credit River Watershed, Ontario [81]	Credit River Watershed gross value estimate, subdivided into wetland services (\$187 million), upland forests (\$71 million), riparian forests (\$51 million), urban forests (\$19 million) and others. Also has gross numbers about size of watershed, so could potentially be translated to meaningful unit values of some kind.	2010	Small brochure	Mike Kennedy and Jeff Wilson	TEEB
			The Economic Value of Water Quality [book, no index #]	Willingness to pay figures for different locations (in Maine, Wisconsin, Pennsylvania and Georgia), and for multiple sites, related to groundwater protection, generally from nitrate contamination. Estimates based on survey responses.	2001	p. 27, 33, 62, 133, and others	Bergstrom, Boyle,	USDA was one supporter
			Title 18. Environmental Quality Chapter 11. Department of Environmental Quality -	Table showing water quality standards detailed figures for maybe 140 are so contaminants		1) p. 16-22 2) p. 24-44 3) p. 10 4) p. 8	(legislation)	State of AZ

Applies 7	To: (any or	all)						
Use	Contam- inant	Benefit Category	Title [our index #]	Subject Focus/Concept (preference surveys, hedonics, benefit transfer, travel costs, etc.)	Year	Page # for \$ ests., other key content	Main Author	Sponsor Agency/ Org.
			Water Quality Standards, Supplement 16-4 [no #]	2) Table of surface waters and designated uses, for hundreds of waters, for wildlife, human health, and agricultural sub-categories 3) salinity standards for Colorado River 4) nutrients		also other pages have details. Glossary and abbr. – p. 3		
			Economic benefits of improved water quality in the Delaware River [no #]	Scientists have called for raising the 1960s dissolved oxygen criteria from 3.5 mg/L to 5.0 mg/L to ensure year-round propagation of anadromous American shad and Atlantic sturgeon. Would also mitigate atmospheric warming, which would lead to reductions in dissolved oxygen saturation. Additional valuation shows direct use benefits to range from \$371 million to \$1.1 billion per year. Other benefits: recreational boating (\$46–\$334 million), recreational fishing (\$129–\$202 million), agriculture (\$8–\$188 million), nonuse value (\$76–\$115 million), viewing/ boating/fishing (\$55–\$68 million), bird watching (\$15–\$33 million), property value (\$13–27 million), water supply (\$12–\$24 million), commercial fishing (up to \$17 million), and navigation	2019	[have to buy this] Abstract in the Word file "misc sources"		
			The Economic Value of Water Quality [41]	Iterative choice survey results for a very large, nationally representative, Web-based panel imply an average valuation of \$32 for each percent increase in lakes and rivers in the region for which water quality is rated "Good." Authors' conclusions: "Survey results did not resolve [various] issues regarding environmental benefits, such as disentangling the influence of passive use, option values,	2008		W. Kip Viscusi	

Applies	Γο: (any or	all)						
Use	Contam- inant	Benefit Category	Title [our index #]	Subject Focus/Concept (preference surveys, hedonics, benefit transfer, travel costs, etc.)	Year	Page # for \$ ests., other key content	Main Author	Sponsor Agency/ Org.
				and related concepts. Did show that even those who do not use lakes or rivers have substantial values, but these values are much greater for those who use such water bodies, particularly if they make such trips outside the region." This study could in theory be related to removing a water from the "impaired" list				
			2017 Five-Year Review of the 2012 Recreational Water Quality Criteria [92]	Some health burden dollar figures, based on a series of study summaries. Discusses relationship among health-related water - related outbreaks, the CDC, etc. throughout the country. Mostly technical and not economic issues discussed.	2017	Mainly on page 30	Agency acknowledge s various contributors	EPA
			The Missing Benefits of Clean Water and the Role of Mismeasured Pollution [96]	No actual dollar amounts, but discusses proportional relationships between stated costs and different types of benefits and different studies, and the general issue of how water quality benefits can be underestimated. Authoritative author.	2019		David A. Keiser	EPA
			Drinking Water Quality and Human Health: An Editorial [109]	Primarily a bibliography of studies, with some introductory discussion and summarization, related to drinking water quality and human health	2019		Patrick Levallois and Cristina M. Villanueva	NIH
			National Recommended Water Quality Criteria: 2002. Human Health Criteria Calculation Matrix [118]	Table of numerical, etc. standards related to human health. Comprehensive coverage includes cancer potency factors (q1*s); reference doses (RfDs); relative source contributions (RSCs); fish intake values; and	2002		None mentioned	EPA

Applies 7	Γο: (any or	all)						
Use	Contam- inant	Benefit Category	Title [our index #]	Subject Focus/Concept (preference surveys, hedonics, benefit transfer, travel costs, etc.)	Year	Page # for \$ ests., other key content	Main Author	Sponsor Agency/ Org.
				equations used to derive the corresponding human health criteria				
			Payment for Best Management Practices and Downstream Water Quality: A Spatially Integrated Economic- Hydrological Model of the Lake Erie Water Basin [123]	Focus on agricultural nutrient runoff, especially phosphorus, from the Maumee River watershed entering Lake Erie. Interviewed farmers. Some \$ number values and could be useful because of the rarity of agricultural connections.	2019	p. 4, elsewhere	Hongxing Liu	Workshop ⁶
				Estimates of benefits in dollars by recreation category. Models are estimated using data from the 1994 National Survey of Recreation and the Environment and from water quality modeling simulations of the National Water Pollution Control Assessment Model	170013	Starting page 16	George R. Parsons	EPA
				According to author, uses "the most comprehensive set of files ever compiled on water pollution and its determinants, including 50 million pollution readings from 240,000 monitoring sites and a network model of all U.S. rivers, to study water pollution's trends, causes, and welfare consequences." Very technical dissertation with some potentially usable cost and benefit aggregate numbers.	2018. Values relate to various years	PDF p. 2, 4, 22, 31 and others	David A. Keiser and Joseph S. Shapiro	USDA
			Review of monetary and nonmonetary evaluation	Old material but some land valuation impact figures, for lakes, wetlands, mostly in Florida.	1995	p. 103 +, crop production	Timothy Feather	COE

⁶ Workshop on Integrated Assessment Models and the Social Costs o Water Pollution, Cornell University

Applies T	o: (any or a	all)						
Use	Contam- inant	Benefit Category	Title [our index #]	Subject Focus/Concept (preference surveys, hedonics, benefit transfer, travel costs, etc.)	Year	Page # for \$ ests., other key content	Main Author	Sponsor Agency/ Org.
			of environmental investments [129]	Recreation values by category for rivers and lakes, Florida; crop production data; other benefit values.		value data; benefit values 106, 107, +		
			Selected published DARRP economics literature ⁷ [135]	Bibliography of academic studies on economic valuation of environmental damage (lost recreation, restoration costs, from oil spills, etc.)	2020		(Bibliography)	NOAA
			The Green Book. Central [UK] Government Guidance on Appraisal and Evaluation [136]	General-information handout for policy CBA (not just environmental policy); Annex (appendix) 1 has framework for valuation of nonmarket goods, including land prices, health risks, biodiversity, etc.; links to Environmental Valuation Reference Inventory (www.evri.ca), which may be useful (but mostly relates to Europe)	2018	p. 75 on		British gov.?
			Large-Scale Ecosystem Service Valuation: Progress, Prospects, and	Technical review of using "benefits transfer" to value WTP for increases in water quality; some numbers may be useful; points out complexities of properly applying benefits transfer method		PDF page 26, 46-51	Robert J. Johnston and Dana Marie Bauer	USDA
			Valuing Mortality Risk Reductions [131]	Explores several meta-analyses that have become available, which provide insight into the results of two methods: 1) Revealed preference studies of wage compensation for occupational risks, and 2) Stated preference research, which has improved methodologically and expanded dramatically. Some numbers	2011	p. 6	Maureen Cropper	Resources for the Future

 $^{^7\,}https://darrp.noaa.gov/sites/default/files/taxonomy-attachments/Selected\%20 Publications\%20 from\%20 DARRP\%20 Economists.pdf$

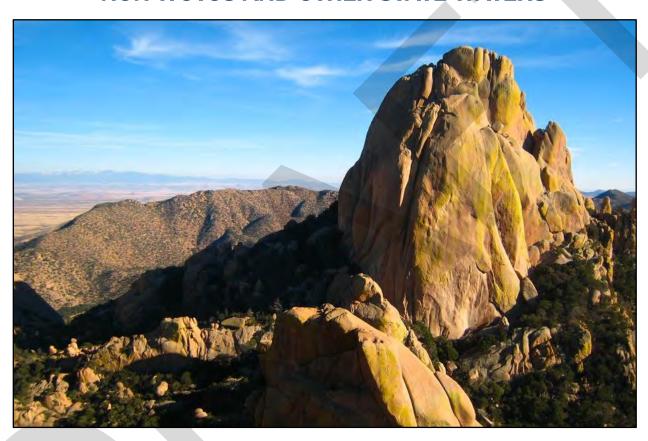
Applies 7	Γο: (any or	all)						
Use	Contam- inant	Benefit Category	Title [our index #]	Subject Focus/Concept (preference surveys, hedonics, benefit transfer, travel costs, etc.)	Year	Page # for \$ ests., other key content	Main Author	Sponsor Agency/ Org.
			[originating doc: Economic Analysis for Hydropower Project Relicensing: Guidance and Alternative Methods] Chapter 7 [119]	Costs and benefits related to removal of dams, and includes benefits such as restoration of fish populations, so could be of some calibrating use	1998	PDF p. 4-6, other		USFWS
			Ecosystems and Human Well-being - A Report of the Millennium Ecosystem Assessment [111]	A synthesis of multiple studies "organized around the core questions originally posed to the assessment: How have ecosystems and their services changed? What has caused these changes? How have these changes affected human well-being? How might ecosystems change in the future and what are the implications for human well-being? And what options exist to enhance the conservation of ecosystems and their contribution to human well-being?" International scope with some real numbers, some of which could possibly be useful in a calibrating way	2005	PDF page 20, on	Numerous	UN
			Colorado River & Its Tributaries [106]	Results of a household survey of residents in Colorado River-basin states was conducted by phone to estimate recreational activity that occurred along or on the Colorado River and its tributaries (River) over the course of a year, and numbers are then matched to recreationists' expenditure data. Breakdown by specific recreation types so could be useful for calibrating other data		Summaries on pages 2-4; elsewhere	Southwick Associates	Protect The Flows
			National Recommended Water Quality Criteria - Aquatic Life Criteria Table [149]	Numerous contaminant types and criteria by fresh and saltwater. This may be duplicative of other material from Arizona or could possibly fill gaps	Recent, & #s from			EPA

Applies ⁻	Γο: (any or a	all)						
Use	Contam- inant	Benefit Category	Title [our index #]	Subject Focus/Concept (preference surveys, hedonics, benefit transfer, travel costs, etc.)	Year	Page # for \$ ests., other key content	Main Author	Sponsor Agency/ Org.
					prior yrs			
			National Recommended Water Quality Criteria - Human Health Criteria Table ⁸ [150]	Similar to previous, but for human health				EPA
			Economic Analysis for the Proposed Definition of "Waters of the United States" – Recodification of Pre- existing Rules [152]	Expansion of other document in folders about the economic analysis of the WOTUS redesignation, this one focusing on "Recodification of Pre-existing Rules." Has cost figures that may be relevant, probably from a calibrating standpoint	2017	p. 13, 14		EPA
			2016 Clean Water Act Assessment (July 1, 2010 to June 30, 2015), Arizona's Integrated 305(b) Assessment and 303(d) Listing Report [7]	Detailed assessment by water body, "designated uses," which give a sense of benefit categories, variations in water quality standards by water body, technical details, reasons why things go "wrong" in quality, etc. Might be useful with Title 18 data	2017		Aiko Condon and Jason Jones	ADEQ
			NCEE Working Paper: Property values and water quality: A nationwide meta-analysis and the implications for benefit transfer [54]	In Conclusion section, authors state that "The existence of this meta-dataset and our subsequent meta-analysis provides a means for practitioners to conduct benefit transfer, and assess how improvements in water quality from local, regional, and even national policies are capitalized into housing values." However, there are no actual dollar figures in the report, suggesting that additional probing would be required to capture the implied value of this	2019		Dennis Guignet	EPA - National Center for Environ- mental Economics

 $^{^{8}\} https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table.$

Applies To: (any or all)								
Use	Contam- inant	Benefit Category	Title [our index #]	Subject Focus/Concept (preference surveys, hedonics, benefit transfer, travel costs, etc.)	Year	Page # for \$ ests., other key content	Main Author	Sponsor Agency/ Org.
				research (particularly relevant because property value research is relatively scarce)				

DRAFT MODELING ECONOMIC AND SOCIAL COSTS AND BENEFITS FOR WATER QUALITY CONDITIONS FOR NON-WOTUS AND OTHER STATE WATERS



Prepared for:

Arizona Department of Environmental Quality

P.O. # PO0000400338

March 4, 2022 – Preliminary Deliverable

PREPARED BY

McClure Consulting LLC with The Natelson Dale Group, Inc.

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Introduction

ADEQ rulemaking requirements include establishing criteria for the economic, social and environmental costs and benefits for listing or delisting waters for protection in their program, and for setting standards for non-WOTUS and other waters of the state. Accordingly, this assignment is understood by the consulting team (Consultants) to focus on services pertaining to modeling the economic and social costs and benefits associated with decisions related to adoption of water quality standards¹ for non-WOTUS waters and other waters of the state, and for listing or delisting waters for protection within a new Surface Water Protection program.

In fulfillment of these purposes, the Consultants outlined a series of tasks applicable to both a Preliminary Deliverable package, which is this document, and final deliverables for subsequent completion. The outline of this work is shown in Appendix A.

To expedite the framework for the benefit/cost analysis with respect to this assignment, ADEQ identified three different classes of water bodies that could involve designation as non-WOTUS protected surface waters. ADEQ also identified specific water bodies to represent each class, as shown below:

Class 1 – Sky Island Stream. Representative Water – Stronghold Canyon, Cochise County

Sky Islands are isolated mountain ranges in southeastern Arizona. These mountains contain a number of perennial or intermittent surface waters that have no significant nexus to a traditionally navigable water. The streams will die out in the deserts surrounding the sky island but are still important components of Arizona's overall hydrology.

Class 2 – Isolated Lakes. Representative Water – Pintail Lake, Show Low

Allen Severson Memorial Wildlife Area/Pintail Lake is known in abbreviated form as "Pintail Lake." This wildlife area is actually a man-made wetland created from treated wastewater, and is recognized nationally as one of the first of its kind in the country.

Class 3 – Ecologically, Culturally, or Historically significant water. Representative Water – Quitobaquito Pond

As a part of Organ Pipe Cactus National Monument, the National Park Service, in 1961, removed all old structures from the Quitobaquito Pond site, drained and deepened the pond, and constructed improvements to accommodate visitors and help protect the area.

These water bodies are described and discussed additionally in the material that follows.

¹ The Consultants' understanding with respect to "standards" is that standards can relate to a designation or other status of a water body but that current modeling efforts will not necessarily include quantified changes in standards for specific contaminants.

ADEQ requested, for purposes of this assignment, that the Consultants follow the benefit and cost estimating procedures outlined in a recent document prepared by EPA and the Department of the Army.² This approach required some interpretation by the Consultants.

First, the nationwide and state-by-state approaches that EPA takes with respect to their analyses in EPA (2021) must be understood in terms of how they relate to individual water bodies within any particular state. Costs are quantified at the state level for the 404 program, based on estimates of the <u>number of permits</u> that would be generated by changes in definition of waters, and then the direct costs (to permitees) of <u>permits</u> and related <u>mitigation</u> measures, and also additionally related <u>administrative costs to the State</u> (401). EPA provides information on costs related to 404 and 401 programs, and this information could be used within this benefit/cost analysis modeling framework under the assumption that the cost estimates on a per-unit (or per-permit) basis would be generally applicable to Arizona, even if the programs are not administered by the state.

These cost factors may not apply directly to the three case study examples. Since one of the sites is within a national monument, one is a relatively isolated mountain stream, and one relies on treated wastewater, activities requiring a Section 404 permit would be unlikely or very limited in these areas irrespective of changes in the definition of waters. Nevertheless, the concepts and approach described above should be applicable to Arizona waters generally.

Second, EPA (2021) provides an "annualized" cost (per-household and total) for each state based on an assumed number of permits/acres per year and using various factors, with costs projected over a 20-year analysis horizon. The 20-year cash outflow is then discounted to a present capitalized value and then converted to an annualized "payment." Benefits are treated similarly, and incorporate estimates such as the proportion of population within a "local" (as opposed to non-local) relationship to wetlands.

For the ADEQ case studies, it is recommended that EPA's cost annualizing methodology <u>not</u> be replicated. The reason for this recommendation is that the case studies will apply to discrete/individual projects (rather than a statewide assumption about generic multiple projects over 20 years). Since Section 404/401 costs for individual projects are assumed to be a one-time event, a straightforward cost per permit is recommended. Benefits pertinent to a particular water body, on the other hand, require an annualizing treatment similar to that applied by EPA to costs, because these are ongoing.

The Consultants also recommend a technical modification to the benefit modeling approach used in EPA (2021), which is to use a linear regression model instead of the nonlinear model used by EPA for their state-level estimates. The linear model affords a less complex process, which is also well suited to individual water bodies of relatively small size.³

² Economic Analysis For The Proposed Revised Definition of WOTUS Rule. 2021. The study, referred to as "EPA (2021)" in this document, is a joint effort of the Environmental Protection Agency (EPA) and the Department of the Army.

³ This recommendation is supported by Klaus Moeltner in conversations with him, and is also reflected in his paper used by EPA, Moeltner, et. al. (2019). Waters of the United States: Upgrading wetland valuation via benefit transfer. *Ecological Economics*, *164*, 106336.

Finally, for purposes of this assignment, certain waters of the state, including one of the case study examples, may not necessarily meet the official (federal or Arizona) definition of "wetland." Nevertheless, the value of a wetland to the public is assumed to be similar enough to the case study situations, and other potentially affected waters in Arizona, to allow the use of EPA's benefit modeling procedure (modified as noted herein) to derive Arizona estimates.

Limitations in benefit and cost definitions inherent in EPA (2021)

EPA acknowledges certain limitations in its relatively narrow approach to identifying benefits from protecting the quality of water. Moreover, a specific/individual water being evaluated may provide unique environmental and economic benefits beyond the EPA-calculated values for "typical" wetlands. Topics they mention as left unaddressed⁴ include: the benefits of wetland carbon sequestration, the ability of wetlands to help allay the future effects of climate change, such as severe weather events, and the ability of wetlands to reduce soil erosion and retain flood waters (p. 86).

The EPA report focuses on assigning monetary values to benefits associated with wetland expansion/preservation, specifically through a meta-analysis of multiple wetland valuation studies that together provide insights into estimates of the public's willingness-to-pay (WTP) for wetland preservation. The nature of this type of analysis combines many different conditions and considerations, which tend to vary among the series of studies analyzed. The derived estimates can then be both generalized and also viewed in terms of the influence of the differing various conditions on monetary valuation. Using information from the EPA document, the source study that EPA relied heavily upon for this analysis, and supplementary data available through EPA, valuation differences attributable to varying conditions can be extracted, in order to structure models more closely tailored to specific localized conditions (for the waters, their uses, their surroundings, accessible populations, etc.). See also Tables 1 through 3.

Cost considerations mentioned in the EPA report *but not quantified* except for 401-related costs as they relate to the 404 program, are summarized in the following statement:

"The definition of "waters of the United States" has a substantial effect on the implementation of other CWA programs, including the section 303(c) water quality standards program, the section 311 oil spill prevention program, the section 401 water quality certification program, and the section 402 NPDES permit program. A revised definition of "waters of the United States" would affect these CWA programs at both the federal and state level. Potential effects may vary based on a state's authority under their own state law to address aquatic resources and their capacity to address these aquatic resources through non-regulatory efforts" (EPA (2021) Executive Summary page xiv).

⁴ In one discussion stating that they "omit known sources of benefits that are inherently difficult to quantify" (EPA 2021, p. xi).

In recognition of these limitations, particularly as they apply to benefit categories, the Consultants will further describe, in the final deliverable, potentially expanded modeling methods that may be appropriate for ADEQ benefit/cost analysis at some point in the future.

Preliminary analysis model structure

Figures 1 and 2 on the following pages, for the basic model structure and annotated version, respectively, summarize the framework of a benefit/cost analysis model that will be expanded upon as part of the final deliverable for this assignment.

Defining characteristics of the model

The model will ideally:

- Illustrate how multiple cases, conditions, etc. fit into a framework having multiple commonalities along with distinct components.
- Be designed to both summarize a process and link, conceptually and computationally, to the submodels that relate to the whole.
- Be user-friendly, "transportable," and adaptable.
- Encompass complexity and still remain comprehensible and media-manageable.

Physical structure and key components:

The final model will be based on an Excel workbook with multiple tabs, with submodels linking to the main table series. It will have a hierarchical framework: level 1 submodels are linked to relevant level 2 submodels, etc. and master data tables are feeding multiple submodels. Model overview diagrams in Figures 1 and 2 are intended to orient users to the model components, certain components of which are described below (letters and numbers match the diagram labeling).

A. Inputs, general:

- Standards by water type, if/as applicable to modeling, and relationships to uses, etc.
- Per-user (or per-something else) values tied to specific water use types, such as specific recreation activities, etc.
- Cost factors: permitting or other compliance (by some kind of unit), for public and private entities; user charges per unit by type; consideration of other factors such as health impacts (as burden), as applicable or practical at this level of analysis.
 - o Directly quantifiable economic, indirectly quantifiable economic, social.
- Benefit categories:
 - Directly quantifiable economic, indirectly quantifiable, or identifiable only, economic, social.

B. Inputs, specific to a water body:

- Contaminants, standard, influence on uses, (as applicable)
- Human conditions: water supply, recreational potential, passive use/appreciation, property values

- Aquatic and wildlife conditions: variations by climate, effluent-dependent, ephemeral, etc.
- Affected populations by type of interaction.
- Cost factors: any variation from general factors based on specifics of water body; opportunity costs.
- Benefits: full scope and according to how topics fit into EPA-based model framework.
- 5. Costs tabulation: See Tables 4 through 6.
- 9. Sensitivity analysis component: Review of how the overall model structure relates to the specific analysis conditions in ways that could tend to over- or underestimate costs and/or benefits.

C. Affected entities:

- For benefits: geographic and demographic description of affected populations that are both "local" and "nonlocal" with respect to water body.
- For costs: types of entities affected, with costs allocated among them to extent possible.



FIGURE 1. BASIC MODEL STRUCTURE

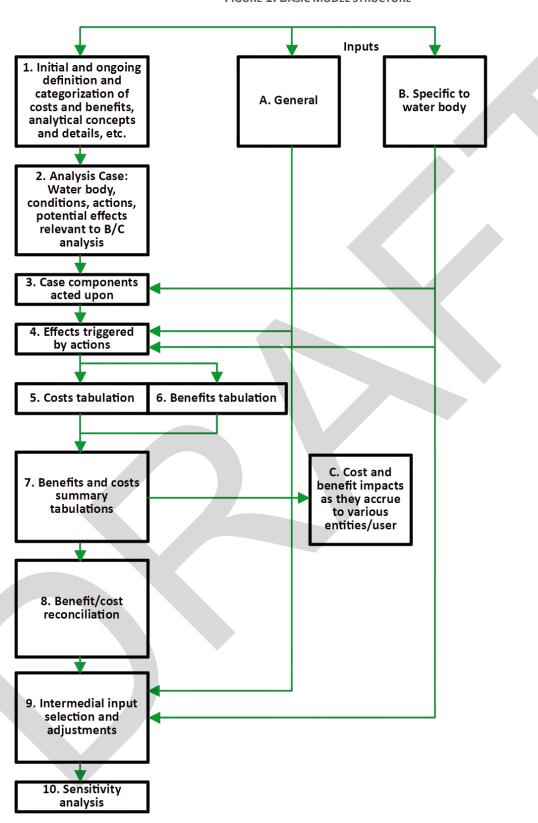


FIGURE 2. ANNOTATED MODEL STRUCTURE Inputs Elements extracted from A as 1. Initial and ongoing B. Specific Explanatory appropriate: definition and to water A. General narrative of • Contaminant types, as categorization of body current applicable costs and benefits. model Aspects of water use/users analytical concepts affected and details, etc. Affected populations • Cost Factors, applications • Benefits as they fit with model framework 2. Analysis Case: Water body, conditions, actions, · Standards, as applicable, and related potential effects relevant to B/C Per-user/unit values per use/perception analysis · Cost factors: compliance user charges, mitigation, permits, admin. Benefit categories, scope of and as modeled 3. Case components acted upon 4. Effects triggered by actions Conditions, actions, categories, geographic areas, etc. affecting 5. Costs tabulation 6. Benefits tabulation By category 7. Benefits and costs C. Cost and benefit impacts as they accrue to summary tabulations various entities/user Characteristics of affected population Types of entities affected 8. Benefit/cost reconciliation 9. Intermedial input selection and adjustments Selected sensitivity analysis variables 10. Sensitivity analysis

Modeling Economic and Social Costs and Benefits for Water Quality Standards for Non-WOTUS and Other State Waters
McClure Consulting LLC, with The Natelson Dale Group, Inc.

Alignment of Arizona benefit and cost categories with EPA methods and documentation

Benefits pertaining to water class examples

Tables 1 through 3 show the following benefit conditions related to each of the three class type examples addressed in this assignment:

- Benefit categories / components
- Relevant quantities
- Proposed (final deliverable) approaches to benefit valuation
- Data resources / next steps (final deliverable)

Topics addressed within each of the three water class types will have broad applicability to other Arizona waters that would eventually be subject to analysis.



TABLE 1. CLASS 1 – SKY ISLAND STREAM. STRONGHOLD CANYON

Benefit Categories/Components	Relevant Quantities	Proposed (Phase 2) Approaches to Benefit Valuation	Data Resources/ Next Steps (Phase 2)
Wetlands, General	From existing project description:	General wetlands value (EPA) applied to length or surface area	(Tentative) meta regression analysis of EPA-compiled willingness-to-pay (WTP)
Habitat	4-mile hiking/equestrian trail0.12-mile interpretive trail	of stream	data; Consultants have preliminarily evaluated EPA database and will
Recreation	·	As a supplement to EPA's all-	construct site-specific "predictive
Hiking	Additional information/	inclusive values for wetlands	analysis" based on data variables
Backpacking	clarifications needed (Phase 2):	benefits, Consultants will	relevant to this site. ⁵
Rock climbing	Length or surface area of	quantify (where possible) and	
• Equestrian	stream(s)	qualitatively document	Audubon study for birding/recreational
Birding	Habitat for any rare or	unique/special values for which	values (county-specific and activity-
	endangered species? (At a	this site is likely to exceed the	specific data are available).
Cultural significance (Cochise)	minimum, Consultants will review the list of birds and	lower-bound estimates captured within the EPA factors. For this	If available, compile use/revenue data
Uniqueness of "sky islands"	document any especially	site, these special values would	from:
ornqueriess or sky islands	significant species)	include:	Cochise Stronghold Campground
Within Coronado National		Birding/recreational values	(USFS)
Forest		 Economic/employment benefits associate with outdoor recreation 	Cochise Stronghold Retreat (Dharma Treasure Retreat)
		businesses	Qualitatively document business/economic benefits to outdoor
			recreation businesses listed in links
			section of Cochise Canyon website (and
			conduct supplemental online research
			to identify other affected businesses)

⁵ As part of this evaluation, the Consultants conferred with the prime contributor to the EPA's benefit analysis based on the willingness-to-pay principle, Klaus Moeltner of Virginia Tech, who graciously provided additional data and direction regarding this effort.

TABLE 2. CLASS 2 – ISOLATED LAKES. PINTAIL LAKE

Benefit Categories/Components	Relevant Quantities	Proposed (Phase 2) Approaches to Benefit Valuation	Data Resources/ Next Steps (Phase 2)
Wetlands, General Habitat (birds) Habitat (big game) Recreation • Birding • Hunting • Hiking Within the larger Apache-Sitgreaves National Forests (with a full range of camping and other outdoor recreational activities)	 From existing project description: 50 acres of water within 250-acre fenced area South Marsh fluctuates from 15-50 acres of flooded meadow Additional information/clarifications needed (Phase 2): Clarify acreages (is South Marsh part of total or separate?) Habitat for any rare or endangered species? (At a minimum, Consultants will review the list of birds and document any especially significant species) 	General wetlands value (EPA) applied to surface area of wetlands As a supplement to EPA's allinclusive values for wetlands benefits, Consultants will quantify (where possible) and qualitatively document unique/special values for which this site is likely to exceed the lower-bound estimates captured within the EPA factors. For this site, these special values would include: Birding/hunting/ Recreational values Economic/employment benefits associate with outdoor recreation businesses	(Tentative) meta regression analysis of EPA-compiled willingness-to-pay (WTP) data; Consultants have preliminarily evaluated EPA data base and will construct site-specific "predictive analysis" based on data variables relevant to this site. Audubon study for birding/ recreational values (county-specific and activity-specific data are available). Arizona Department of Fish and Game Study (2002): Economic Importance of Hunting and Fishing Online research to identify any local businesses directly/ indirectly supported by the visitors

TABLE 3. CLASS 3 – ECOLOGICALLY, CULTURALLY, OR HISTORICALLY SIGNIFICANT WATER. QUITOBAQUITO POND

Benefit Categories/Components	Relevant Quantities	Proposed (Phase 2) Approaches to Benefit Valuation	Data Resources/ Next Steps (Phase 2)
Habitat for (and only remaining U.S. populations of) rare and endangered species: Sonoyta mud turtle (listed endangered species) Quitobaquito pupfish (listed endangered species) Quitobaquito spring snail (candidate threatened/endangered species) Desert caper plant Caper butterfly Within the larger Organ Pipe Cactus National Monument (with a full range of camping and other outdoor recreational activities) Religiously significant springs	 From existing project description: Half-acre pond/reservoir (ADEQ RFP) 12.3 acres of critical habitat for mud turtle (USFWS) 0.8-acre pond with 0.34-acre wetland area (NPS) Additional information/clarifications needed (Phase 2): Reconcile acreage estimates (summarized above) from various sources Determine if site is within International Biosphere Reserve 	General wetlands value (EPA) applied to surface area of wetlands As a supplement to EPA's allinclusive values for wetlands benefits, Consultants will quantify (where possible) and qualitatively document unique/special values for which this site is likely to exceed the lower-bound estimates captured within the EPA factors. For this site, these special values would include: Rare/endangered species habitat Cultural/religious values (Indirect) recreational benefits associated with National Monument (Indirect) economic/ employment benefits associate with outdoor recreation businesses	(Tentative) meta regression analysis of EPA-compiled willingness-to-pay (WTP) data; Consultants have preliminarily evaluated EPA data base and will construct site-specific "predictive analysis" based on data variables relevant to this site. FWS economic impact study related to the mud turtle; also review other endangered species valuation literature Audubon study for general (indirect) recreational values If applicable, incorporate valuation literature related to International Biosphere Reserve

Application of EPA's proposed refinement to estimating willingness-to-pay

In Appendix H of EPA (2021), the authors stated an intention, for the final rule analysis, to modify the methods for deriving two of the variables in the estimating equations related to WTP discussed elsewhere in this document: 1) affected number of households, and 2) household incomes for this affected group. In this modified method, a geographic information system (GIS) is used to select the areas in which households are assumed to have either a "local" or "nonlocal" (but still relevant) relationship to any given wetland or set of wetlands. This allows for more precise delineations of potentially affected households, including extension of any specific wetland/analysis area across state boundaries (where EPA had originally confined state-level estimates to state boundaries), and the potential for applying distinctions within affected populations for such things as the values they attach to wetlands (which to some extent can be generalized based on locational differences such as urban/rural, etc.).

This type of GIS-based approach works well with analyses of discrete to water bodies, and will be incorporated into the Consultant's recommendations for modeling as part of the final deliverable.

Cost estimation factors

Tables 4 through 6 show: 1) cost factors, 2) Arizona-specific or national quantified assumptions pertaining to these factors as reflected in EPA documents, and 3) notes on the application of figures to ADEQ benefit/cost modeling, related to the case studies and also general conditions for other waters.



TABLE 4. ESTIMATION FACTORS FOR SECTION 404 USACE PERMIT COSTS

Factor, per EPA	Arizona-specific Assumptions in EPA (2021)	Notes on Application
Average annual increase in Section 404 permits (individual permit, IP)	1.7	For case studies, ADEQ may provide estimated
Average annual increase in Section 404 permits (general permit, GP)	117.0	number of permits per year based on anticipated site-specific uses/activities
Cost per USACE permit in 2017 dollars, IP (low) ⁶	\$14,700	
Cost per USACE permit in 2017 dollars, IP (midpoint)	\$25,000	
Cost per USACE permit in 2017 dollars IP (high)	\$35,300	Adjust to current year dollars based on Consumer
Cost per USACE permit in 2017 dollars, GP (low)	\$4,400	Price Index (CPI)
Cost per USACE permit in 2017 dollars, GP (midpoint)	\$9,600	
Cost per USACE permit in 2017 dollars GP (high)	\$14,700	

TABLE 5. ESTIMATION FACTORS FOR SECTION 404 MITIGATION COSTS

Factor, per EPA	Arizona-specific Assumptions in EPA (2021)	Notes on Application
Average annual increase in mitigation (acres)	13.4	For case studies, ADEQ may provide estimated
Average annual increase in mitigation (linear feet)	879	mitigation requirements based on anticipated site- specific uses/activities
Acreage – linear foot conversion factor	Assume 50' width/buffer (national data)	Need to discuss application with ADEQ staff (not clear how this factor is applied in EPA analysis)
Mitigation costs per acre in 2017 dollars (low)	\$294	
Mitigation costs per acre in 2017 dollars (high)	\$675	Adjust to current year dollars based on
Mitigation costs per stream linear foot in 2017 dollars (low)	\$54,000	Construction Cost Index (CCI)
Mitigation costs per stream linear foot in 2017 dollars (high)	\$84,000	

⁶ For each permit type, the EPA (2021) document used the low end of the range of observed costs as the "low" estimate and the high end of the range as the "high" estimate. The cost numbers shown in the tables on this page are from a supplemental spreadsheet produced by EPA, outside the EPA (2021) document, creation date 9/29/2021 (file name: EPA-HQ-OW-2021-0602-0054_content). Note that GP high costs = IP low costs, per the data source, in Table 4.

Factor, per EPA	Arizona-specific Assumptions in EPA (2021)	Notes on Application
		As appropriate, override default AZ assumptions from EPA study (if ADEQ staff has customized data for specific sites/projects) Source of AZ data in EPA study is noted as Tim Wade, AZ GFD ILF Manager

TABLE 6. ESTIMATION FACTORS FOR STATE COSTS FOR SECTION 401 REVIEWS

Factor, per EPA	Arizona-specific ¹ Assumptions in EPA (2021)	Notes on Application
Annual number of affected permits (individual)	10.30	For case studies, ADEQ may provide estimated
Annual number of affected permits (general)	246.40	number of affected permits per year based on
Annual number of affected permits (total)	256.70	anticipated site-specific uses/activities (for cost calculations, breakdown between individual and general permits is not needed)
FTE staff time per permit (low)	0.00069	Assumptions in EPA study are not state-specific but
FTE staff time per permit (mean)	0.00872	are based on available data from 11 states (not
FTE staff time per permit (high)	0.02138	including Arizona) As appropriate, override default assumptions from EPA study based on ADEQ's forthcoming in-house cost analysis
Average annual salary for state employee in 2017 dollars (U.S. average – not Arizona-specific)	\$60,210	If using default salary assumption, adjust to current year dollars based on Gross Domestic Product
Overhead factor used to adjust salary to total cost per employee	1.6	(GDP) Deflator As appropriate, override default assumptions from EPA study based on ADEQ's forthcoming in-house cost analysis

Except as noted.

Literature review of Arizona-related documents potentially relevant to current or future benefit/cost modeling for Arizona waters

At ADEQ's direction, the Consultants reviewed a series of documents within ADEQ's developing on-line library. The annotated bibliography resulting from this analysis is attached as Appendix B.



Appendix A. Outline of Task Order Reports

		Α	В
	<u>Topic</u>	Preliminary Deliverables	<u>Final Deliverables</u> (includes Preliminary Material plus any additions as noted)
1	Applying EPA methods ⁷ for quantifying water-related costs and benefits to Arizona		
1a	 General implications, limitations, and advantages of using 	Narrative summary of issues	Narrative, including ADEQ commentary on preliminary material
1b	 Cost categories: types, nature of 	Inventory and brief description	
1c	 Benefit categories: types, nature of 	Inventory and brief description, also noting the crossover of benefits as costs foregone (and vice versa),	
1d	 Specific applications for quantifying Arizona conditions 		Description of how the framework for applying EPA methods, etc. supports the specific language in ADEQ's rulemaking requirements
1di	 Relationship of EPA categories to types of Arizona cost and benefit conditions: overlaps and distinctions 	Matrix relating EPA categories, relatively general by nature, to Arizona categories that tend to be more specific and in some cases unique; and EPA's acknowledgment of topical and analytical limitations within their analysis framework	Description of how Arizona- specific categories of both costs and benefits, subsumed in EPA's methodologies, could, in future analyses frameworks, be identified, quantified, and otherwise treated to capture a more comprehensive range of costs and benefits and their interrelationships
1dii	 Relationship of three case studies to general applicability within state 	Matrix relating cost and benefit categories within the three case studies to EPA categories (as EPA generalizes them) and to the broader range of Arizona categories as outlined above	How the conditions in the three case studies relate to the descriptive framework discussed immediately above in 1di
2	Benefit/cost modeling framework for Arizona		
2a	Model structure	Analysis flow diagram, main and sub-models (in overview and	(1) Model framework in XL workbook; (2) model with values applied and quantified results,

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⁷ Economic Analysis For The Proposed Revised Definition of WOTUS Rule. 2021.

		А	В
	<u>Topic</u>	Preliminary Deliverables	Final Deliverables (includes Preliminary Material plus any additions as noted)
		detailed versions), with narrative description	for each of the three case-study waters
2b	 Translation of EPA cost factors to Arizona 	Description of how used in model	Application of numbers to 2a.B(2)
2c	 Translation of EPA benefit model framework to Arizona 	Description of how used in model	Quantification of equations for application to 2a.B(2)
	• EPA's description of EPA's preference, in the future, for a GIS-based benefit transfer approach (as per Appendix H of their study)	Discussion of how this approach is readily adaptable to (and preferable for) current and any future analysis systems generated for Arizona	Application of concept into model (2a.B), and description of how it would be generally applied to Arizona cases, how fits with the advantages anticipated by EPA, etc.
3	Other benefit/cost modeling in AZ		
3a	Annotated bibliography of pertinent documents	Annotated bibliography of selected reports/report types, highlighting aspects particularly relevant to this assignment	Annotated bibliography, additional relevant entries as identified
3b	 Types of benefits and costs addressed, and relevant levels of detail in treatment 	Findings summarized	
3c	 Modeling methods from the literature potentially applicable to water- related analyses, present and future 		Description of potential expanded modeling methods and how they could be applied to current conditions and to 1di.B

Appendix B. Annotated Bibliography

References

1. Arizona Administrative Register

Summary: The Administrative Register (Register) is a legal publication published by the Administrative Rules Division that contains information about rulemaking activity in the state of Arizona. The issues referenced below include code sections being amended and introduced to Chapter 11, which involves the Department of Environmental Quality Water Quality Standards.

Study Resource: These publications mainly refer to and make reference to topics that contribute to the Economic, Small Business, and Consumer Impact Statements. The studies referred to and referenced in this publication provide a brief summary of tourism, agriculture, or other benefits as well as cost categories or data produced from the findings. The following items are addressed in individual registers cited below:

Arizona Administrative Register (1995). Notice of Proposed Rulemaking, Title 18, Environmental Quality, Chapter 11, Department of Environmental Quality, Water Quality Standards, Volume 1, Issue 50.

Publication Study Resource: Proposed new section to the modification of water quality standards on the grounds of net ecological benefit based on the following criteria:

- 1. The discharge of effluent creates or supports an ecologically valuable aquatic; wetland, or riparian habitat in an area where such resources are limited
- 2. The cost of treatment to comply with a water quality standard is so high that it is more cost effective to eliminate the discharge of effluent rather than upgrade treatment
- 3. It is feasible for a point source discharger to completely eliminate the discharge of effluent
- 4. The environmental benefits associated with the discharge of effluent under a modified water quality standard exceed the environmental costs associated with elimination of the discharge and destruction of the effluent dependent ecosystem
- 5. All practicable point source control discharge programs, including local pretreatment, waste minimization, and source reduction programs are implemented
- 6. The discharge of effluent under a modified water quality standard will not cause or contribute to a violation of a water quality standard that has been established for a downstream surface water
- 7. The discharge of effluent will not produce or contribute to the concentration of a pollutant in the tissues of aquatic organisms or wildlife that is likely to be harmful to humans or wildlife through food chain concentration.

Arizona Administrative Register (1996). Notice of Final Rulemaking, Title 18, Environmental Quality,
Chapter 11, Department of Environmental Quality, Water Quality Standards For Surface Waters

– Economic Small Business and Consumer Impact Statement, Volume 2, Issue 20.

Publication Study Resource: The adopted Net Ecological Benefit rule provides a benefit to the owners of wastewater treatment plants that support or create effluent dependent waters because it provides a mechanism for relief from a water quality standard that otherwise might force costly treatment plant

upgrades. The adopted rule also provides ecosystem benefits in that it provides a regulatory incentive to maintain and preserve in-stream flows in areas where riparian and aquatic resources are limited. The continued discharge of effluent may provide net ecological benefits, even though an applicable water quality standard is not being met. Examples of possible ecological benefits include:

- A. Enhancement, expansion or restoration of aquatic and riparian habitat for native, threatened or endangered aquatic species, or for migratory waterfowl
- B. Provision or enhancement of habitat or food sources for native, threatened and endangered species that are terrestrial
- C. Enhancement of species diversity
- D. Enhancement or restoration of riparian values (e.g. cottonwood/willow habitat, improved bird and wildlife habitat)

Arizona Administrative Register (2001). Notice of Proposed Rulemaking, Title 18, Environmental Quality, Chapter 11, Department of Environmental Quality, Water Quality Standards, Volume 7, Issue 11.

Publication Study Resource: Proposed decision criteria for Social and economic impact of Tier 3 antidegradation protection: The Director may take into consideration the potential social and economic impact of a unique water classification and the establishment of Tier 3 antidegradation protection, including:

- a. Impact of a prohibition of new point source discharges and expansion of existing point source discharges, including possible limits on discharges to the tributaries of a proposed unique water and possible impacts on growth and development.
- b. Impact of possible future restrictions on land use activities in a unique waters watershed, including cattle grazing, timber harvesting, mining, recreation, and agriculture.
- c. The impact of stricter requirements for §401 certification of federal permits and licenses, including NPDES and §404 permits.
- d. Impact on private property rights and the potential for regulatory "takings."
- e. Ecosystem and preservation values.

Arizona Administrative Register (2002). Notice of Final Rulemaking, Title 18, Environmental Quality, Chapter 11, Department of Environmental Quality, Water Quality Standards, Volume 8, Issue 13.

Arizona Administrative Register (2008). Notice of Final Rulemaking, Title 18, Environmental Quality, Chapter 11, Department of Environmental Quality, Water Quality Standards, Volume 14, Issue 52.

Arizona Administrative Register (2016). Agency Certificate Notice of Final Rulemaking, Title 18, Environmental Quality, Chapter 11, Department of Environmental Quality, Water Quality Standards, Volume 22, Issue 36.

Publication Study Resource: ADEQ proposed to eliminate the requirement that a discharger have a plan to eliminate the discharge under active consideration as part of what must be demonstrated. Communities and developers should benefit by eliminating an extra burden in seeking to use high quality effluent to create aquatic and riparian ecosystems.

Arizona Administrative Register (2017). Notice of Final Rulemaking, Title 18, Environmental Quality,
Chapter 11, Department of Environmental Quality, Water Quality Standards, Volume 23, Issue 6.

Publication Study Resource: Estimated costs and benefits to consumers and the public mentioned in recreation activities (e.g., Ironman at Tempe Town Lake), fishing activities, and agricultural productivity.

Arizona Administrative Register (2019). Notice of Final Rulemaking, Title 18, Environmental Quality, Chapter 11, Department of Environmental Quality, Water Quality Standards, Volume 25, Issue 5.

Publication Study Resource: See notes regarding interface with AOT studies under Agriculture in Arizona's Economy and The Economic Contributions of Water-related Outdoor Recreation in Arizona, below.

2. Agriculture in Arizona's Economy

Summary: This report explores agriculture's contribution to the Arizona economy by examining the entire agribusiness system in Arizona.

Study Resource: The economic contribution analysis was conducted using input-output modeling and the premiere software for this type of analysis, IMPLAN Version 3.1. IMPLAN is a modeling system of a regional economy that is based on national averages of production conditions. This model was refined based on the best available data to more accurately reflect production conditions in Arizona.

Applicability to current benefit/cost estimating procedures: The IMPLAN system translates direct economic effects of some action into secondary effects, reflecting the multiplier effects of actions through the economic system. This common practice in economic impact assessments would be a logical eventual extension of cost and benefit estimating in relation to water body changes/designations.

Kerna, A., & Frisvold, G. (2014). Agriculture in Arizona's Economy: An Economic Contribution Analysis.

Department of Agricultural & Resource Economics. University of Arizona.

3. Buehman Canyon Creek – Economic Benefits of Unique Water Designation Study of Buehman Canyon Creek

Summary: This study reviews the economic benefits of Buehman Canyon Creek for the consideration of determining the water body as a unique water designation.

Study Resource: The information summarized in this study provides guidance on what factors need to be considered in a comprehensive examination of probable costs and benefits in the economic impact statement on a proposed unique water designation.

Applicability to current benefit/cost estimating procedures: This study mentions economic benefits that are quantifiable, but does not include the data methodology used to support the economic benefits associated with the proposed unique water designation for Buehman Canyon Creek.

Colby, B.G. (1996) Buehman Canyon Creek – Economic Benefits of Unique Water Designation Study – March 1996. *Arizona Department of Environmental Quality*.

4. The Economic Benefits of Recreation in Rural Arizona

Summary: This report provides a summary analysis of tourism and recreation as factors influencing the state's economy and local economy's withing the state.

Study Resource: This report summarizes park recreation tourism economic benefits, the benefits to rural areas, and the need to develop more facilities to access recreation lands. Drawing from the published survey of visitors of Arizona State Parks conducted between 1987-1988, visitors were asked how much money their group spent during their trip within 50 miles of the state park they were visiting, average expenditures were produced per visitor group per trip and were applied to park attendance counts to document total expenditures spent within 50 miles of state parks by visitors in 1987.

Applicability to current benefit/cost estimating procedures: The reference cited for this source entitled "The 1987-1988 Use Study of Arizona State Parks Visitors" for the Arizona State Parks Board in 1989 provides some quantifiable data for visitor expenditures that lends itself to establishing captured economic benefits of this type.

Spear, S. (1989) Rural Arizona... The Economic Benefits of Recreation, A Summary Analysis of Tourism and Recreation as Factors Influencing State and Local Economies. *Arizona State Parks Board Statewide Planning Section*.

5. The Economic Contributions of Water-related Outdoor Recreation in Arizona

Summary: A study of outdoor recreational activity on or along the water to estimate the level of participation in the state and the contributions from these activities to the county and state economies.

Study Resource: The analysis is structured around estimating three sets of metrics: participation, spending, and economic contributions. Participation estimates for this study relied largely on two data sources to characterize outdoor recreation on or along the water. Economic Contributions were estimated by combining spending estimates with data that models economic sector interactions in a given geography. Expenditure data were collected for different categories (e.g., groceries, fuel, equipment, etc.) as part of the OIA survey, which enabled allocation of spending to specific economic sectors. These data were then run through an IMPLAN™ model of the Arizona statewide economy using software produced by MIG, Inc. The resulting county-level and water-specific estimates reflect the contribution that outdoor recreation in those locales has on the statewide economy. Appendix A in the document provides additional background information on economic contributions.

Applicability to current benefit/cost estimating procedures: See notes on IMPLAN under Agriculture in Arizona's Economy. The Arizona Office of Tourism (AOT) sponsors periodic generalized studies related to Arizona visitors, including types of activities, expenditures, economic impacts, etc. To the extent that benefit/cost modeling of water bodies/designations is expanded into specific consideration of benefits related to riparian-focused activities, these location/activity-specific studies (#4 as well as this one) can add to the specificity of benefits associated with activities of particular interest.

Southwick Associates (2019). The Economic Contributions of Water-related Outdoor Recreation in Arizona: A Technical Report on Study Scope, Methods, and Procedures. *Audubon Arizona*.

6. Socioeconomic consequences of mercury use and pollution

Summary: In the past, human activities often resulted in mercury releases to the biosphere with little consideration of undesirable consequences for the health of humans and wildlife. This paper outlines the pathways through which humans and wildlife are exposed to mercury.

Study Resource: This paper examines the life cycle of mercury from a global perspective and then identifies several approaches to measuring the benefits of reducing mercury exposure, policy options for reducing Hg emissions, possible exposure reduction mechanisms, and issues associated with mercury risk assessment and communication for different populations. This study also briefly reviews the methods used to quantify the benefits to human health associated with reduced mercury exposure, which include Benefit-cost Analysis and the Cost-effectiveness Analysis.

Applicability to current benefit/cost estimating procedures: This paper does not include any quantifiable data used in its review of the Benefit-cost Analysis or Cost-effectiveness Analysis.

Swain, E. B., Jakus, P. M., Rice, G., Lupi, F., Maxson, P. A., Pacyna, J. M., ... & Veiga, M. M. (2007). Socioeconomic consequences of mercury use and pollution. *Ambio*, 45-61.

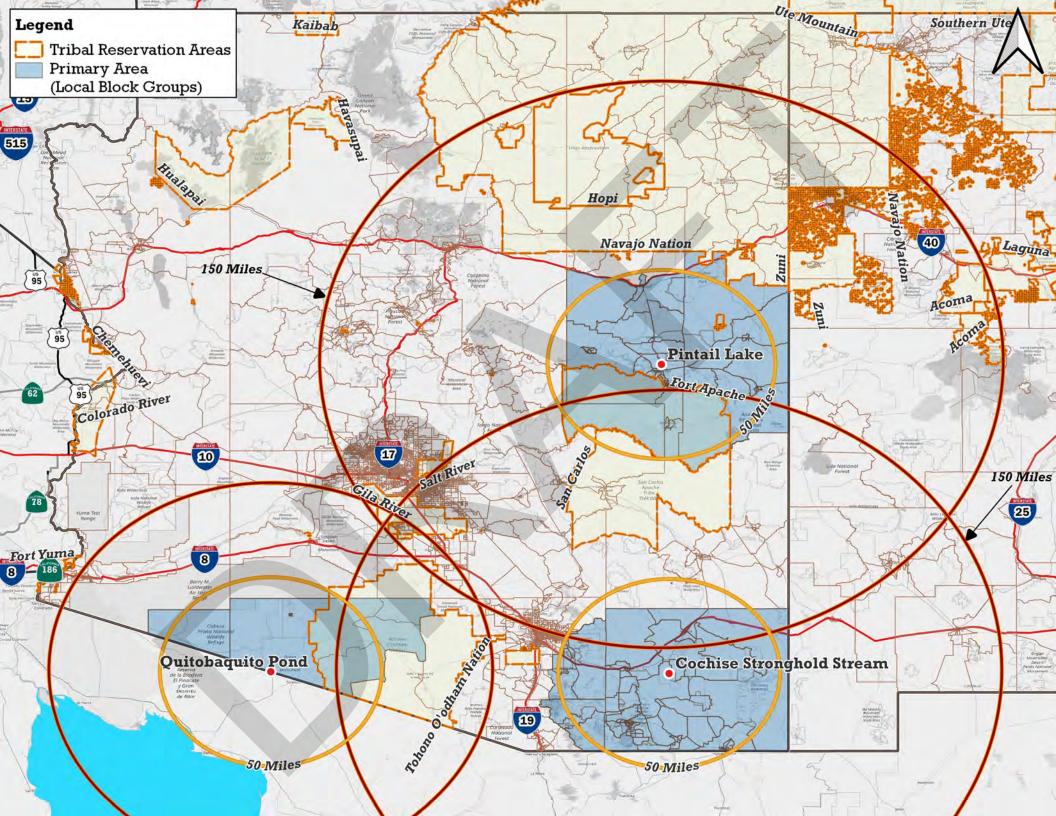
7. Nature-based Tourism and the Economy of Southeastern Arizona

Summary: This study documents expenditures in the Sierra Vista area by visitors to the San Pedro Riparian National Conservation Area (RNCA) and by bird watchers at Ramsey Canyon Preserve. Information on visitor expenditures, characteristics and preferences is reported, along with implications for nature-based tourism in southeastern Arizona. This study examined visitation to only two natural areas and so economic impacts reported here represent only a portion of the impacts of visitor spending associated with all nature preserves located in southeastern Arizona. The study indicates that 95% of visitors to Ramsey Canyon and the San Pedro RNCA go to at least one other site in southern Arizona on a typical visit to the area, and make expenditures in communities located near these sites.

Study Resource: The expenditure analysis indicates the importance of an overnight stay for communities to experience significant economic benefits from visitors.

Applicability to current benefit/cost estimating procedures: See notes regarding interface with AOT studies under *The Economic Contributions of Water-related Outdoor Recreation in Arizona*, above.

Crandall, K., Leones, J., & Colby, B. G. (1992). Nature-based Tourism and the Economy of Southeastern Arizona: Economic Impacts of Visitation to Ramsey Canyon Preserve and the San Pedro Riparian National Conservation Area, Final Report. Department of Agricultural and Resource Economics, the University of Arizona.



ADEQ 50-State Cost/Benefit Analysis

QUESTION PRESENTED:

Do other states have environmental regulation that require "environmental, economic, social" cost-benefit analyses and how is the analysis set up?

BRIEF ANSWER:

Most states have statutory and regulatory language reference that a "cost-benefit analysis1" must be conducted; however, most statutes and regulations do not outline the structure of what shall be included in a cost-benefit analysis.

Additionally, most states have statutory language that includes the requirement of a cost-benefit analysis within the definition of "unreasonable adverse effects on the environment" in regard to pesticide or mosquito control. This language is taken from Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), 7 U.S.C. § 136(bb). FIFRA's cost-benefit analysis weighs benefits such as avoided health threats, lower food prices, and higher yields, against costs from the use of pesticides, such as illnesses from exposure, deaths, environmental destruction, and expenses accrued from equipment and application. 36 J. Envtl. L. & Litig. 69.

As a recommendation when developing a cost-benefit analysis, the Administrative Law Review article "Transparency in Agency Cost-Benefit Analysis" suggests various frameworks for considering transparency in cost-benefit analyses in order to improve decisionmaking and accountability. 72 ADMLR 157. This article may provide a helpful framework for ADEQ to consider while developing a cost-benefit analysis.

Connecticut provides a requirement of a "cost-benefit analysis" when evaluating state agency actions affecting the environment. C.G.S.A. § 22a-1b(c)(6).

"Each state department, institution or agency responsible for the primary recommendation or initiation of actions which may significantly affect the environment shall in the case of each such proposed action make a detailed written evaluation of its environmental impact before deciding whether to undertake or approve such action. All such environmental impact evaluations shall be detailed statements setting forth the following: ... (6) an analysis of the short term and long term economic, social and environmental costs and benefits of the proposed action;"

This might be an interesting read as it provides some recommendations for CBA processes and agency procedures.

The EPA's "Benefit and Cost Analysis for the Effluent
Limitations Guidelines and Standards for the
Steam Electric Power Generating Point
Source Category"
https://www.epa.gov/sites/default/files/2015-10/documents/steam-electric_benefit-cost-analysis_09-292015.pdf

¹ 72 Admin. L. Rev. 157

[&]quot;Transparency in Agency Cost-Benefit Analysis"

C.G.S.A. § 22a-1b(c)(6).

In 2015, the EPA promulgated a regulation revising effluent limitations and strengthening controls on discharges from steam electric power plants. As a requirement of its promulgation, the EPA conducted a cost-benefit analysis and published the report titled "Benefit and Cost Analysis for the Effluent Limitations Guidelines and Standards for the Stream Electric Power Generating Point Source Category." The report presents the social cost-benefit analysis of the final rule and references additional cost-benefit analysis conducted in support of this rule. EPA-821-R-15-005.

Furthermore, the EPA website provides documents and tools relating to economic cost-benefit analyses for air pollution regulations that may offer guidance when developing the structure of a cost-benefit analysis.

Economic and Cost Analysis for Air Pollution Regulations, EPA (2020), https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations.

LAW:

Arizona

- ARS 49-437. Conditional orders; standards; rules.
 - (A)(2)(b) There is no reasonable relationship between the economic and social cost of, and benefits to be obtained from, achieving compliance.
- ARS 41-1024. Time and manner of rulemaking.
 - E. Unless exempted by section 41-1005 or 41-1057 or unless the rule is an emergency rule made pursuant to section 41-1026, if the agency chooses to make the rule, the agency shall submit a rule package to the council and to the committee. The rule package shall include:
 - 1. The preamble.
 - 2. The exact words of the rule, including existing language and any deletions.
 - 3. The economic, small business and consumer impact statement.
- ARS 41-1055. Economic, small business impact statement.
 - A. The economic, small business and consumer impact summary in the preamble shall include:
 - 1. An identification of the proposed rule making, including all of the following:
 - (a) The conduct and its frequency of occurrence that the rule is designed to change.
 - (b) The harm resulting from the conduct the rule is designed to change and the likelihood it will continue to occur if the rule is not changed.
 - (c) The estimated change in frequency of the targeted conduct expected from the rule change.
 - 2. A brief summary of the information included in the economic, small business and consumer impact statement.
 - 3. If the economic, small business and consumer impact summary accompanies
 a proposed rule or a proposed expedited rule, the name and address of agency
 employees who may be contacted to submit or request additional data on the

information included in the economic, small business and consumer impact statement.

- o B. The economic, small business and consumer impact statement shall include:
 - 1. An identification of the proposed rule making.
 - 2. An identification of the persons who will be directly affected by, bear the costs of or directly benefit from the proposed rule making.
 - 3. A cost benefit analysis of the following:
 - (a) The probable costs and benefits to the implementing agency and other agencies directly affected by the implementation and enforcement of the proposed rule making. The probable costs to the implementing agency shall include the number of new full-time employees necessary to implement and enforce the proposed rule. The preparer of the economic, small business and consumer impact statement shall notify the joint legislative budget committee of the number of new full-time employees necessary to implement and enforce the rule before the rule is approved by the council.
 - (b) The probable costs and benefits to a political subdivision of this state directly affected by the implementation and enforcement of the proposed rule making.
 - (c) The probable costs and benefits to businesses directly affected by the proposed rule making, including any anticipated effect on the revenues or payroll expenditures of employers who are subject to the proposed rule making.
 - 4. A general description of the probable impact on private and public employment in businesses, agencies and political subdivisions of this state directly affected by the proposed rule making.
 - 5. A statement of the probable impact of the proposed rule making on small businesses. The statement shall include:
 - (a) An identification of the small businesses subject to the proposed rule making.
 - (b) The administrative and other costs required for compliance with the proposed rule making.
 - (c) A description of the methods prescribed in section 41-1035 that the agency may use to reduce the impact on small businesses, with reasons for the agency's decision to use or not to use each method.
 - (d) The probable cost and benefit to private persons and consumers who are directly affected by the proposed rule making.
 - 6. A statement of the probable effect on state revenues.
 - 7. A description of any less intrusive or less costly alternative methods of achieving the purpose of the proposed rule making, including the monetizing of the costs and benefits for each option and providing the rationale for not using nonselected alternatives.
 - 8. A description of any data on which a rule is based with a detailed explanation of how the data was obtained and why the data is acceptable data. An agency advocating that any data is acceptable data has the burden of proving that the

data is acceptable. For the purposes of this paragraph, "acceptable data" means empirical, replicable and testable data as evidenced in supporting documentation, statistics, reports, studies or research.

- C. If for any reason adequate data are not reasonably available to comply with the requirements of subsection B of this section, the agency shall explain the limitations of the data and the methods that were employed in the attempt to obtain the data and shall characterize the probable impacts in qualitative terms. The absence of adequate data, if explained in accordance with this subsection, shall not be grounds for a legal challenge to the sufficiency of the economic, small business and consumer impact statement.
- D. An agency is not required to prepare an economic, small business and consumer impact statement pursuant to this chapter and is not required to file a petition pursuant to subsection E of this section for the following rule makings:
 - 1. Initial making, but not renewal, of an emergency rule pursuant to section 41-1026.
 - 2. Proposed expedited rule making or final expedited rule making.
- E. Before filing a proposed rule with the secretary of state, an agency may petition the council for a determination that the agency is not required to file an economic, small business and consumer impact statement. The petition shall demonstrate both of the following:
 - 1. The rule making decreases monitoring, record keeping, costs or reporting burdens on agencies, political subdivisions, businesses or persons.
 - 2. The rule making does not increase monitoring, record keeping, costs or reporting burdens on persons subject to the proposed rule making.
- F. The council shall place a petition under subsection E of this section on the agenda of its next meeting if at least four council members make such a request of the council chairperson within two weeks after the filing of the petition.
- G. The preamble for a rule making that is exempt pursuant to subsection D or E of this section shall state that the rule making is exempt from the requirements to prepare and file an economic, small business and consumer impact statement.
- H. The cost-benefit analysis required by subsection B of this section shall calculate only the costs and benefits that occur in this state.
- I. If a person submits an analysis to the agency regarding the rule's impact on the competitiveness of businesses in this state as compared to the competitiveness of businesses in other states, the agency shall consider the analysis.

<u>Arkansas</u>

- A.C.A. § 14-176-102. Definitions. (Economic Development and Tourism Generally)
 - (5) "Economic impact and cost-benefit analysis" means an economic analysis created with an economic modeling software program or industry recognized software program that measures the anticipated local or regional economic benefits of an economic development project against the costs of the incentive proposal of the economic development program prepared by a nationally or regionally recognized independent economic forecasting firm or an Arkansas-based-four-year institution of higher education with an active economic research or analysis department

- A.C.A § 15-4-3203. Amendment 82 project qualification.
 - (c) The commission shall initiate the process of selecting a proposed project for referral to the to the General Assembly by performing an economic impact and cost-benefit analysis to evaluate the capability of a sponsor and the feasibility of a proposed project and to determine if the proposed project has the potential to be a qualified Amendment 82 project. The economic impact and cost-benefit analysis shall include all other economic incentives offered by the state in connection with the proposed project.

Colorado

- C.R.S. 25-11-203. Approval of facilities, sites, and shipments for disposal of radioactive waste.
 - (2)(c)(VI)(c) As used in paragraph (b) of this subsection (2), "environmental assessment" means a report and assessment submitted to the department by a facility upon and in connection with application for a license, a five-year license renewal, or license amendment pertaining to the facility's receipt of radioactive material, proposing to receive any radioactive material for storage, processing, or disposal at a facility that addresses the impacts of the receipt for storage, processing, or disposal of the radioactive material. The environmental assessment shall contain all information deemed necessary by the department, and shall include, at a minimum:
 - (VI) An analysis of the environmental, economic, social, technical, and other benefits of the proposed application against environmental costs and social effects while considering available alternatives;
- C.R.S. 25-8-503 Permits when required and when prohibited variances.
 - (8) Where a permit requires treatment to levels necessary to protect water quality standards and beyond levels required by technology-based effluent limitation requirements, the division must determine whether or not any or all of the water-quality-standard-based effluent limitations are reasonably related to the economic, environmental, public health, and energy impact to the public and affected persons, and are in furtherance of the policies set forth in sections 25-8-102 and 25-8-104. The division's determination shall be based upon information available to it including information provided during the public comment period on the draft permit or in response to specific requests for information. Such determinations shall be included as a part of the written record of the issuance of the final permit, whether or not a variance is available under subsection (9) of this section to alter the water quality standard based effluent limitations.
- **C.R.S. 25-8-303.5** General permits process for changing permit requirements.
 - (1) With respect to a general permit listed in section 25-8-502 (1)(b)(I)(G), when proposing new or amended permit requirements for dischargers to meet, to obtain, or to maintain authorization for discharges under the permit, the division shall:
 - (d) Upon request by an affected party, consider and give due weight to a costbenefit analysis:
 - (I) Received by the division during the comment phase set forth in paragraph (c) of this subsection (1);
 - (II) Concerning one or more proposed requirements that are not already required by federal or state statute or rule;

- (III) Prepared by a third party chosen from an approved list of analysts, as developed by the division in consultation with representatives of the industries that are subject to general permitting; and
- (IV) Paid for by the affected party.
- C.R.S. 24-4-103 Rule-making procedure definitions statutory citation correction.
 - o (2.5)(a) At the time of filing a notice of proposed rule-making with the secretary of state as the secretary may require, an agency shall submit a draft of the proposed rule or the proposed amendment to an existing rule and a statement, in plain language, concerning the subject matter or purpose of the proposed rule or amendment to the office of the executive director in the department of regulatory agencies. The executive director, or his or her designee, shall distribute the proposed rule or amendment, the agency's statement concerning the subject matter or purpose of the proposed rule or amendment, and any cost-benefit analysis prepared pursuant to this section to all persons who have submitted a request to receive notices from the department of regulatory agencies about proposed rule-making. Any person may, within five days after publication of the notice of proposed rule-making in the Colorado register, request that the department of regulatory agencies require the agency submitting the proposed rule or amendment to prepare a cost-benefit analysis. The executive director, or his or her designee, shall determine, after consultation with the agency proposing the rule or amendment, whether to require the agency to prepare a cost-benefit analysis. If the executive director, or his or her designee, determines that a cost-benefit analysis is required, the agency shall complete a cost-benefit analysis at least ten days before the hearing on the rule or amendment, shall make the analysis available to the public by posting the analysis on the agency's official website, and shall submit a copy to the executive director or his or her designee. The executive director, or his or her designee, shall post the analysis on the department of regulatory agencies' official website. By filing an additional notice published in the Colorado register, the agency may postpone the hearing on the rule or amendment to comply with the requirement to complete the cost-benefit analysis at least ten days before the hearing. Failure to complete a requested cost-benefit analysis pursuant to this subsection (2.5) shall preclude the adoption of such rule or amendment. Such cost-benefit analysis shall include the following:
 - (I) The reason for the rule or amendment;
 - (II) The anticipated economic benefits of the rule or amendment, which shall include economic growth, the creation of new jobs, and increased economic competitiveness;
 - (III) The anticipated costs of the rule or amendment, which shall include the direct costs to the government to administer the rule or amendment and the direct and indirect costs to business and other entities required to comply with the rule or amendment;
 - (IV) Any adverse effects on the economy, consumers, private markets, small businesses, job creation, and economic competitiveness; and
 - (V) At least two alternatives to the proposed rule or amendment that can be identified by the submitting agency or a member of the public, including the costs and benefits of pursuing each of the alternatives identified.

- (b) The executive director, or his or her designee, shall study the cost-benefit analysis and may urge the agency to revise the rule or amendment to eliminate or reduce the negative economic impact. The executive director, or his or her designee, may inform the public about the negative impact of the proposed rule or the proposed amendment to an existing rule.
- (c) Any proprietary information provided to the department of revenue by a business or trade association for the purpose of preparing a cost-benefit analysis shall be confidential.
- (d) If the agency has made a good faith effort to comply with the requirements of paragraph (a) of this subsection (2.5), the rule or amendment shall not be invalidated on the ground that the contents of the cost-benefit analysis are insufficient or inaccurate.
- (e) This subsection (2.5) shall not apply to orders, licenses, permits, adjudication, or rules affecting the direct reimbursement of vendors or providers with state funds.
- (f) Repealed.
- (g) Each state rule-making agency with a website containing rule-making information shall include the following information on its website:
 - (I) Information about the cost-benefit analysis process set forth in this subsection (2.5); and
 - (II) A link to the online regulatory notice enrollment form created by the
 executive director of the department of regulatory agencies or the
 executive director's designee and listed on the department's website.
- C.R.S. 25-7-110.5 Required analysis of proposed air quality rules.
 - (4)(c) The proponent and the division shall select one or more of the following economic impact analyses. The commission may ask affected industry to submit information with regard to the cost of compliance with the proposed rule, and, if it is not provided, it shall not be considered reasonably available. The economic impact analysis required by this subsection (4) shall be based upon reasonably available data and shall consist of one or more of the following:
 - (I) Cost-effectiveness analyses for air pollution control that identify:
 - (A) The cumulative cost including but not limited to the total capital, operation, and maintenance costs of any proposed controls for affected business entity or industry to comply with the provisions of the proposal;
 - (B) Any direct costs to be incurred by the general public to comply with the provisions of the proposal;
 - (C) Air pollution reductions caused by the proposal;
 - (D) The cost per unit of air pollution reductions caused by the proposal;
 and
 - (E) The cost for the division to implement the provisions of the proposal; or
 - (II) Industry studies that examine the direct costs of the proposal on directly affected entities that may be either in the form of a business analysis (The

regulatory impacts on the general business climate or subsets thereof) or an industry analysis (the regulatory impacts on specific industries), including:

- (A) The characteristics and current economic conditions of the impacted business or industry sector; and
- (B) The projected impacts on the growth of the affected industry sectors with and without implementation of the proposal; and
- (C) How the proposal may effect or alter the growth of the affected industry sector; and
- (D) The direct cost of the proposal on the affected industry sector; or
- (III) An economic impact analysis that:
 - (A) Identifies the industrial and business sectors that will be impacted by the proposal; and
 - (B) Quantifies the direct cost to the primary affected business or industrial sector; and
 - (C) Incorporates an estimate of the economic impact of the proposal on the supporting business and industrial sectors associated with the primary affected business or industry sectors.
- C.R.S. 25-7-1208. Economic or cost-effectiveness analysis not required. (RELATED TO ^)
 - Notwithstanding section 25-7-110.5, the commission shall not conduct an economic impact analysis, cost-effectiveness analysis, or any other analyses required by section 25-7-110.5 in considering a voluntary agreement or the emission limitations contained therein.

Connecticut

- C.G.S.A. § 22a-1b. Evaluation by state agencies of actions affecting the environment. Public scoping process. Environmental monitor.
 - The General Assembly directs that, to the fullest extent possible:
 - (a) Each state department, institution or agency shall review its policies and practices to insure that they are consistent with the state's environmental policy as set forth in sections 22a-1 and 22a-1a.
 - o (b)
- (1) Each sponsoring agency shall, prior to a decision to prepare an environmental impact evaluation pursuant to subsection (c) of this section for an action which may significantly affect the environment, conduct an early public scoping process.
- (2) To initiate an early public scoping process, the sponsoring agency shall provide notice on a form that has been approved by the Council on Environmental Quality, which shall include, but not be limited to, the date, time and location of any proposed public scoping meeting and the duration of the public comment period pursuant to subdivision (3) of this subsection, to the council, the Office of Policy and Management and any other state agency whose activities may reasonably be expected to affect or be affected by the proposed action.

- (3) Members of the public and any interested state agency representatives may submit comments on the nature and extent of any environmental impacts of the proposed action during the thirty days following the publication of the notice of the early public scoping process pursuant to this section.
- (4) A public scoping meeting shall be held at the discretion of the sponsoring agency or if twenty-five persons or an association having not less than twenty-five persons requests such a meeting within ten days of the publication of the notice in the Environmental Monitor. A public scoping meeting shall be held not less than ten days following the notice of the proposed action in the Environmental Monitor. The public comment period shall remain open for at least five days following the meeting.
- (5) A sponsoring agency shall provide the following at a public scoping meeting: (A) A description of the proposed action; (B) a description of the purpose and need of the proposed action; (C) a list of the criteria for a site for the proposed action; (D) a list of potential sites for the proposed action; (E) the resources of any proposed site for the proposed action; (F) the environmental limitations of such sites; (G) potential alternatives to the proposed action; and (H) any information the sponsoring agency deems necessary.
- (6) Any agency submitting comments or participating in the public scoping meeting pursuant to this section shall include, to the extent practicable, but not be limited to, information about (A) the resources of any proposed site for the proposed action, (B) any plans of the commenting agency that may affect or be affected by the proposed action, (C) any permits or approvals that may be necessary for the proposed action, and (D) any appropriate measures that would mitigate the impact of the proposed action, including, but not limited to, recommendations as to preferred sites for the proposed action or alternatives for the proposed action that have not been identified by the sponsoring agency.
- (7) The sponsoring agency shall consider any comments received pursuant to this section or any information obtained during the public scoping meeting in selecting the proposed actions to be addressed in the environmental impact evaluation and shall evaluate in its environmental impact evaluation any substantive issues raised during the early public scoping process that pertain to a proposed action or site or alternative actions or sites.
- c) Each state department, institution or agency responsible for the primary recommendation or initiation of actions which may significantly affect the environment shall in the case of each such proposed action make a detailed written evaluation of its environmental impact before deciding whether to undertake or approve such action. All such environmental impact evaluations shall be detailed statements setting forth the following: (1) A description of the proposed action which shall include, but not be limited to, a description of the purpose and need of the proposed action, and, in the case of a proposed facility, a description of the infrastructure needs of such facility, including, but not limited to, parking, water supply, wastewater treatment and the square footage of the facility; (2) the environmental consequences of the proposed action, including cumulative, direct and indirect effects which might result during and subsequent to the proposed action; (3) any adverse environmental effects which cannot

be avoided and irreversible and irretrievable commitments of resources should the proposal be implemented; (4) alternatives to the proposed action, including the alternative of not proceeding with the proposed action and, in the case of a proposed facility, a list of all the sites controlled by or reasonably available to the sponsoring agency that would meet the stated purpose of such facility; (5) an evaluation of the proposed action's consistency and each alternative's consistency with the state plan of conservation and development, an evaluation of each alternative including, to the extent practicable, whether it avoids, minimizes or mitigates environmental impacts, and, where appropriate, a description of detailed mitigation measures proposed to minimize environmental impacts, including, but not limited to, where appropriate, a site plan; (6) an analysis of the short term and long term economic, social and environmental costs and benefits of the proposed action;² (7) the effect of the proposed action on the use and conservation of energy resources; and (8) a description of the effects of the proposed action on sacred sites or archaeological sites of state or national importance. In the case of an action which affects existing housing, the evaluation shall also contain a detailed statement analyzing (A) housing consequences of the proposed action, including direct and indirect effects which might result during and subsequent to the proposed action by income group as defined in section 8-37aa and by race, and (B) the consistency of the housing consequences with the state's consolidated plan for housing and community development prepared pursuant to section 8-37t. As used in this section, "sacred sites" and "archaeological sites" have the same meanings as provided in section 10-381.

o (d)

- (1) The Council on Environmental Quality shall publish a document at least once a month to be called the Environmental Monitor³ which shall include any notices the council receives pursuant to sections 22a-1b to 22a-1i, inclusive, and shall include notice of the opportunity to request a public scoping meeting. Filings of such notices received by five o'clock p.m. on the first day of each month shall be published in the Environmental Monitor that is issued not later than ten days thereafter.
- (2) The Council on Environmental Quality shall post the Environmental Monitor on its Internet site and distribute a subscription or a copy of the Environmental Monitor by electronic mail to any state agency, municipality or person upon request. The council shall also provide the Environmental Monitor to the clerk of each municipality for posting in its town hall.
- (e) Any state department, institution or agency that conducts an environmental impact evaluation pursuant to subsection (c) of this section may enter into a contract with a person for the preparation of such evaluation, provided such department, institution or agency: (1) Guides such person in the preparation of such evaluation, (2) participates in

https://eregulations.ct.gov/eRegsPortal/Browse/ProposedRegulations

² CT Notice of Proposed Rulemaking postings:

³ CT Environmental Monitor: https://portal.ct.gov/CEQ/Environmental-Monitor/Environmental-Monitor---Current-Issue

the preparation of such evaluation, (3) independently reviews such evaluation prior to submitting such evaluation for comment pursuant to section 22a-1d, and (4) assures that any third party responsible for conducting any activity that is the subject of such evaluation is not a party to such contract. Such department, institution or agency may require any such third party responsible for conducting any activity that is the subject of such evaluation to remit a fee to such department, institution or agency in an amount sufficient to pay for the cost of hiring a person to prepare such evaluation in accordance with the provisions of this subsection.

- Code § 22a-47. Definitions. (Pesticide Control)
 - (z) "Unreasonable adverse effects on the environment" means any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide

Delaware

- 3 Del. C. § 1202. Definitions. (Pesticides)
 - (32) "Unreasonable adverse effects on the environment" means any unreasonable risk to man or the environment, taking into account the economic, social and environmental costs and benefits of the use of any pesticide.
- 29 Del. C. § 8059. Sustainable Energy Utility.
 - o (h)(1)(3)
 - c. Unless otherwise provided, affected energy providers shall prepare and submit to the advisory council 3-year program plans, schedules, and budgets designed to reflect the recommended program portfolios, including the defined energy savings targets. On a 3-year cycle, the advisory council shall review energy efficiency, peak demand reduction, and fuel switching program plans for each affected energy provider and recommend them for approval by the appropriate regulatory authority, if it finds them to be cost-effective through a net-cost-benefit analysis that quantifies expected cost savings when considered in their entirety pursuant to regulations required by paragraph (h)(3) of this section. Such programs must reduce overall utility bills.

Florida

- Fla. Stat. § 161.161. Procedure for approval of projects.
 - (1) The department shall develop and maintain a comprehensive long-term beach management plan for the restoration and maintenance of the state's critically eroded beaches fronting the Atlantic Ocean, Gulf of Mexico, and Straits of Florida. In developing and maintaining this plan, the department shall:
 - (g) Identify short-term and long-term economic costs and benefits of beaches to the state and individual beach communities.
- Fla. Stat. § 633.208. Minimum firesafety standards.
 - (8)(a) The provisions of the Life Safety Code, as contained in the Florida Fire Prevention Code, do not apply to one-family and two-family dwellings. However, fire sprinkler protection may be permitted by local government in lieu of other fire protection-related development requirements for such structures. While local governments may adopt fire sprinkler requirements for one-family and two-family dwellings under this subsection, it

is the intent of the Legislature that the economic consequences of the fire sprinkler mandate on home owners be studied before the enactment of such a requirement. After the effective date of this act, any local government that desires to adopt a fire sprinkler requirement on one-family or two-family dwellings must prepare an economic cost and benefit report that analyzes the application of fire sprinklers to one-family or two-family dwellings or any proposed residential subdivision. The report must consider the tradeoffs and specific cost savings and benefits of fire sprinklers for future owners of property. The report must include an assessment of the cost savings from any reduced or eliminated impact fees if applicable, the reduction in special fire district tax, insurance fees, and other taxes or fees imposed, and the waiver of certain infrastructure requirements including the reduction of roadway widths, the reduction of water line sizes, increased fire hydrant spacing, increased dead-end roadway length, and a reduction in cul-de-sac sizes relative to the costs from fire sprinkling. A failure to prepare an economic report shall result in the invalidation of the fire sprinkler requirement to any one-family or two-family dwelling or any proposed subdivision. In addition, a local jurisdiction or utility may not charge any additional fee, above what is charged to a non-fire sprinklered dwelling, on the basis that a one-family or two-family dwelling unit is protected by a fire sprinkler system.

- Fla. Stat. § 388.011. Definitions. (Mosquito Control)
 - (11) "Unreasonable adverse effects on the environment" means any unreasonable risk to humans or the environment, with due consideration of the economic, social, and environmental costs and benefits of the use of any arthropod control measure.
- Fla. Stat. § 218.076. Reduction or waiver of certain permit processing fees.
 - Notwithstanding any other provision of law, the Department of Environmental Protection shall waive processing fees for renewals of exemptions from the Class G-II ground water standards for sodium, odor, chloride, color, and total dissolved solids issued to any county, municipality, or independent special district, with reclaimed water land application facilities for wastewater effluent disposal when such exemptions were granted by the department by final agency action based upon findings that:
 - (5) There is no reasonable relationship between economic, social, and environmental cost of compliance with the Class G-II ground water standards for sodium, chloride, odor, color, and total dissolved solids, and the economic, social, and environmental benefits of compliance; and
- Fla. Stat. § 487.021. Definitions. (Pesticide Law)
 - (65) "Unreasonable adverse effects on the environment" means any unreasonable risk to humans or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide.

Georgia

- O.C.G.A. § 2-7-52. Definitions. (Control of Pesticides)
 - (34) "Unreasonable adverse effects on the environment" means any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide.

<u>Hawaii</u>

- HRS § 149A-2. Definitions. (Pesticides)
 - "Unreasonable adverse effects on the environment" means any unreasonable risk to humans or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide.
- HRS Div. 1, Title 19, Ch. 342B, Pt. VI. Greenhouse Gas Emissions.
 - "Work plan.
 - o "The work plan shall include but is not limited to the following objectives:
 - "(4) Investigation and development of analytical tools, economic models, or other scientific methods to evaluate the total potential costs and total potential economic and non-economic benefits of the plan for reducing greenhouse gases to the State's economy, environment, and public health;

Idaho

- Idaho Code § 22-3401. Definitions (Pesticides and Chemigation)
 - (35) "Unreasonable adverse effects on the environment" means any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide.

Illinois

- 45 LCS 147/5. Great Lakes-St. Lawrence River Basin Water Resources Compact
 - Section 1.2. Definitions.
 - Environmentally Sound and Economically Feasible Water Conservation Measures mean those measures, methods, technologies or practices for efficient water use and for reduction of water loss and waste or for reducing a Withdrawal, Consumptive Use or Diversion that (i) are environmentally sound, (ii) reflect best practices applicable to the water use sector, (iii) are technically feasible and available, (iv) are economically feasible and cost effective based on an analysis that considers direct and avoided economic and environmental costs and (v) consider the particular facilities and processes involved, taking into account the environmental impact, age of equipment and facilities involved, the processes employed, energy impacts and other appropriate factors.
- 415 ILCS 60/4. Definitions. (Pesticides)
 - 38. "Unreasonable Adverse Effects on the Environment" means the unreasonable risk to the environment, including man, from the use of any pesticide, when taking into account accrued benefits of as well as the economic, social, and environmental costs of its use.
- **55 ILCS 5/5-1062.1**. Stormwater management planning councils in Cook County.
 - (d) The District shall give careful consideration to the recommendations and concerns of the watershed planning councils throughout the planning process and shall coordinate the 6 watershed plans as developed and to coordinate the planning process with the adjoining counties to ensure that recommended stormwater projects will have no significant adverse impact on the levels or flows of stormwater in the inter-county watershed or on the capacity of existing and planned stormwater retention facilities. The District shall include cost benefit analysis in its deliberations and in evaluating priorities for projects from watershed to watershed. The District shall identify in an

annual published report steps taken by the District to accommodate the concerns and recommendations of the watershed planning councils.

Indiana

- Ind. Code Ann. § 14-25-15-1. Enactment of interstate agreement on use of water resources in Great Lakes St. Lawrence River basin.
 - Section 1.2. Definitions.
 - "Environmentally sound and economically feasible water conservation measures" means those measures, methods, technologies, or practices for efficient water use and for reduction of water loss and waste or for reducing a withdrawal, consumptive use, or diversion that:
 - (i) are environmentally sound;
 - (ii) reflect best practices applicable to the water use sector;
 - (iii) are technically feasible and available;
 - (iv) are economically feasible and cost effective based on an analysis that considers direct and avoided economic and environmental costs; and
 - (v) consider the particular facilities and processes involved, taking into account the environmental impact, age of equipment and facilities involved, processes employed, energy impacts, and other appropriate factors.
 - Ind. Code Ann. § 15-16-5-35. "Unreasonable adverse effect on the environment" defined. (Pesticide Use and Application)
 - As used in this chapter, "unreasonable adverse effects on the environment" means an unreasonable risk to humans or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide.
 - o Ind. Code Ann. § 13-18-26-2. Certification along with permit application.
 - A permit described in section 1(a) or 1(b) [IC 13-18-26-1(a) or IC 13-18-26-1(b)] of this chapter may not be issued unless the applicant submits, along with the permit application, a certification that all of the following documents have been prepared and are complete under the requirements of this chapter:
 - (1) A life cycle cost-benefit analysis, as described in section 3 [IC 13-18-26-3] of this chapter.
 - (2) A capital asset management plan, as described in section 4 [IC 13-18-26-4] of this chapter.
 - (3) A cybersecurity plan, as described in section 5 [IC 13-18-26-5] of this chapter.
 - o Ind. Code Ann. § 13-18-26-3. Life cycle cost-benefit analysis.
 - A life cycle cost-benefit analysis must include a comparison of the alternatives of:
 - (1) meeting the water supply or wastewater service needs of the community or area served or proposed to be served through the operation of the water and wastewater treatment plant, as:

- (A) owned and operated; or
- (B) proposed to be owned and operated;
 according to the terms of the permit application; and
- (2) meeting the water supply or wastewater service needs of the community or area served or proposed to be served through one (1) or more other potential means.

Iowa

- **Iowa Code § 206.2**. Definitions. (Pesticides)
 - 31. "Unreasonable adverse effects on the environment" means any unreasonable risk to humans or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide.
- Iowa Code § 455B.176. Criteria considered.
 - In establishing, modifying, or repealing water quality standards the commission shall base its decision upon data gathered from sources within the state regarding the following:
 - 1. The protection of the public health.
 - 2. The size, depth, surface area covered, volume, direction and rate of flow, stream gradient, and temperature of the affected water of the state.
 - 3. The character and uses of the land area bordering the affected water of the state.
 - 4. The uses which have been made, are being made, or may be made of the affected water of the state for public, private, or domestic water supplies, irrigation; livestock watering; propagation of wildlife, fish, and other aquatic life; bathing, swimming, boating, or other recreational activity; transportation; and disposal of sewage and wastes.
 - 5. The extent of contamination resulting from natural causes including the mineral and chemical characteristics.
 - 6. The extent to which floatable or settleable solids may be permitted.
 - 7. The extent to which suspended solids, colloids, or a combination of solids with other suspended substances may be permitted.
 - 8. The extent to which bacteria and other biological organisms may be permitted.
 - 9. The amount of dissolved oxygen that is to be present and the extent of the oxygen demanding substances which may be permitted.
 - 10. The extent to which toxic substances, chemicals or deleterious conditions may be permitted.
 - 11. The economic costs and benefits. The goal shall be a reasonable balance between total costs to the people and to the economy, and the resultant benefits to the people of lowa.

Kansas

- **K.S.A. § 82a-1609**. Cost-benefit analysis of alternatives required prior to request for appropriation; state agency and public review and comment; duties of division of conservation.

- (a) Before the Kansas department of agriculture division of conservation requests any appropriation for any multipurpose small lake project, the chief engineer shall review the cost-benefit analysis of alternatives to the project and shall:
 - (1) Submit the general plan to the appropriate state environmental review agencies pursuant to K.S.A. 82a-325, 82a-326 and 82a-327, and amendments thereto, for review and comment as provided by those sections; and
 - (2) publish notice of the review in the Kansas register, make the general plan available to the public and receive public comments on the proposed project for a period of 30 days following publication of the notice.
- K.S.A. § 82a-2001. Classified stream segments defined; other definitions.
 - As used in this act:
 - (a) (1) "Classified stream segments" shall include all stream segments that are waters of the state as defined in subsection (a) of K.S.A. 65-161, and amendments thereto, and waters described in subsection (d) of K.S.A. 65-171d, and amendments thereto, that:
 - (A) Are indicated on the federal environmental protection agency's reach file 1 (RF1) (1982) and have the most recent 10-year median flow of equal to or in excess of one cubic foot per second based on data collected and evaluated by the United States geological survey or in the absence of stream segment flow data, calculations of flow conducted by extrapolation methods provided by the United States geological survey;
 - (B) have the most recent 10-year median flow of equal to or in excess of
 one cubic foot per second based on data collected and evaluated by the
 United States geological survey or in the absence of stream segment
 flow data, calculations of flow conducted by extrapolation methods
 provided by the United States geological survey;
 - (C) are actually inhabited by threatened or endangered aquatic species listed in rules and regulations promulgated by the Kansas department of wildlife, parks and tourism or the United States fish and wildlife service;
 - (D)
- (i) scientific studies conducted by the department show that during periods of flow less than one cubic foot per second stream segments provide important refuges for aquatic life and permit biological recolonization of intermittently flowing segments; and
- (ii) a cost-benefit analysis conducted by the department and taking into account the economic and social impact of classifying the stream segment indicates that the benefits of classifying the stream segment outweigh the costs of classifying the stream segment, as consistent with the federal clean water act and federal regulations; or
- (E) are at the point of discharge on the stream segment and downstream from such point where the department has issued a national pollutant discharge elimination system permit other than a

permit for a confined feeding facility, as defined in K.S.A. 65-171d, and amendments thereto.

- (2) Classified stream segments other than those described in subsection (a)(1)(E) shall not include ephemeral streams; grass, vegetative or other waterways; culverts; or ditches.
- (3) Any definition of classified stream or "classified stream segment" in rules and regulations or law that is inconsistent with this definition is hereby declared null and void.

Kentucky

- KRS § 217.44. Definitions for chapter. (Pesticide Control)
 - (33) "Unreasonable adverse effects on the environment" means any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide;

Louisiana

- La. R.S. § 30:2018. Environmental assessment hearings.
 - B. The environmental assessment statement provided for in this Section shall be used to satisfy the public trustee requirements of Article IX, Section 1 of the Constitution of Louisiana and shall address the following issues regarding the proposed permit activity:
 - (1) The potential and real adverse environmental effects of the proposed permit activities.
 - (2) A cost-benefit analysis of the environmental impact costs of the proposed activity balanced against the social and economic benefits of the activity which demonstrates that the latter outweighs the former.
 - (3) The alternatives to the proposed activity which would offer more protection to the environment without unduly curtailing non-environmental benefits.
- LAC 33:VII.10518. Standard Waste Tire Collection Center Permit Application.
 - A. Each applicant requesting a standard permit in accordance with these regulations shall complete the permit application and submit it to the administrative authority. In addition, the standards in LAC 33:VII.10527 shall be incorporated into the appropriate items below. Submission of the following information shall be provided on the application, which is available on the department's website:
 - 22. required information regarding facility site assessments as follows:
 - a. a discussion demonstrating that the potential and real adverse environmental effects of the facility have been avoided to the maximum extent possible;
 - b. a cost-benefit analysis demonstrating that the social and economic benefits of the facility outweigh the environmental-impact costs;
 - c. a discussion and description of possible alternative projects that would offer more protection to the environment without unduly curtailing non-environmental benefits;

- d. a discussion of possible alternative sites that would offer more protection to the environment without unduly curtailing nonenvironmental benefits; and
- e. a discussion and description of the mitigating measures which would offer more protection to the environment than the facility, as proposed, without unduly curtailing non-environmental benefits.
- LAC 33:IX.303. Permit Application Information. (Water Pollution Control Permit)
 - F. The following additional information shall be required in all applications for new permits and if not addressed by the applicant, the application is incomplete and not acceptable for review.
 - 1. Have the potential and real adverse environmental effects of the proposed facility been avoided to the maximum extent possible?
 - 2. Does a cost benefit analysis of the environmental impact costs balanced against the social and economic benefits of the proposed facility demonstrate that the latter outweighs the former?
 - 3. Are there alternative projects which would offer more protection to the environment than the proposed facility without unduly curtailing nonenvironmental benefits?
 - 4. Are there alternative sites which would offer more protection to the environment than the proposed facility site without unduly curtailing nonenvironmental benefits?
 - 5. Are there mitigating measures which would offer more protection to the environment than the facility as proposed without unduly curtailing nonenvironmental benefits?

Maine

- 7 M.R.S. § 604. Definitions. (Pesticides)
 - 32. Unreasonable Adverse Effects on the Environment. "Unreasonable adverse effects on the environment" means any unreasonable risk to human beings or the environment, taking into account the economic, social and environmental costs and benefits of the use of any pesticide.
- 5 M.R.S. § 8063-A. Analysis of benefits and costs. (Rulemaking)
 - In addition to the economic impact statement required under section 8052, subsection 5-A and the fiscal impact note required under section 8063, an agency may, within existing budgeted resources and in instances in which the consideration of costs is permitted, conduct an analysis of the benefits and costs of a proposed rule to evaluate the effects of the rule on the distribution of benefits and costs for specific groups and on the overall economic welfare of the State.
 - 1. Contents of a Cost-Benefit Analysis. To the extent permitted within existing resources, a cost-benefit analysis conducted under this section must include, at a minimum, the following information:
 - A. Specification of the baseline condition for the analysis, including all required parameters for the analysis, all assumptions made in specifying the baseline condition and specification of the analysis period;

- B. A description of the methods used to discount future benefits and costs, preferably based on the federal Office of Management and Budget's discount rate for federal projects;
- C. An analysis of changes in the level of economic activity in the State as measured by employment, income and outputs; and
- D. An estimate of the discounted benefits and costs of the proposed rule over the baseline condition, including benefits and costs to specific groups and changes in the economic welfare of the State as a whole over the baseline condition.
- Prior to conducting a cost-benefit analysis under this section, an agency shall determine that sufficient staff expertise and budgeted resources exist within the agency to complete the analysis. The agency shall include a cost-benefit analysis with a copy of a proposed rule when responding to a request for the proposed rule under section 8053, subsection 3-A. When the analysis is conducted on a provisionally adopted major substantive rule, the analysis must be included with the materials submitted to the Executive Director of the Legislative Council under section 8072, subsection 2. A cost-benefit analysis conducted under this section is not subject to judicial review under section 8058.

Maryland

- Md. State Government Code Ann. § 2-1505.2. Economic impact analyses ratings and economic impact analyses of agency regulations on small business.
 - (a)(3) "Economic impact analysis" means an estimate of the cost or the economic benefit to small businesses that may be affected by a regulation proposed by an agency pursuant to Title 10, Subtitle 1 of this article.
- Md. Public Utilities Code Ann. § 7-704.1. Application for offshore wind project.
 - (c) Contents. -- An application shall include:
 - (3) a cost-benefit analysis that shall include at a minimum:
 - (i) a detailed input-output analysis of the impact of the offshore wind project on income, employment, wages, and taxes in the State with particular emphasis on in-State manufacturing employment;
 - (ii) detailed information concerning assumed employment impacts in the State, including the expected duration of employment opportunities, the salary of each position, and other supporting evidence of employment impacts;
 - (iii) an analysis of the anticipated environmental benefits, health benefits, and environmental impacts of the offshore wind project to the citizens of the State;
 - (iv) an analysis of any impact on residential, commercial, and industrial ratepayers over the life of the offshore wind project;
 - (v) an analysis of any long-term effect on energy and capacity markets as a result of the proposed offshore wind project;
 - (vi) an analysis of any impact on businesses in the State; and

- (vii) other benefits, such as increased in-State construction, operations, maintenance, and equipment purchase;
- Md. Environment Code Ann. § 9-406. Safe drinking water emergencies.
 - (c)(2) As part of the Secretary's determination under paragraph (1) of this subsection, the Secretary shall prepare a report that includes:
 - (i) 1 year of statewide monitoring data for the contaminant, which identifies locations in the State where the contaminant level may pose a significant risk to public health;
 - (ii) Peer reviewed assessments, methodologies, and data concerning the particular contaminant; and
 - (iii) A cost/benefit analysis of implementing the proposed standard for the contaminant conducted by the Department that includes:
 - 1. Review and comment by the Department of Commerce; and
 - 2. After the Department provides notice of the analysis and a reasonable opportunity to comment to the affected public water systems, any submitted written statements from public water systems affected by the proposed standard.
- **COMAR 20.61.06.02.** Application Requirements. (Offshore Wind)
 - L. An application shall include a cost-benefit analysis that covers the following items and the assumptions and data that the OSW applicant used to generate each item:
 - (1) An input-output analysis describing the in-state impact on income, employment, wages, and state and local taxes, with particular emphasis on effects on manufacturing employment in the State, as well as the complete set of data and assumptions that the OSW applicant used to generate the inputoutput analysis;
 - (2) An analysis describing expected employment impacts in the State (expressed as full-time equivalent positions), including expected type and duration of employment opportunities, the expected salary range of positions, and other effects resulting from, for example, in-state construction, operations, maintenance, and equipment purchases, and supported by detailed documentation, including any binding commitments;
 - (3) An analysis describing the in-state business impacts of the proposed offshore wind project;
 - (4) An analysis describing anticipated environmental and health impacts, including impacts on the affected marine environment based on publicly available information, related to construction, operation and decommissioning of the proposed offshore wind project, including direct emissions impacts created by the proposed offshore wind project related to carbon dioxide, oxides of nitrogen, sulfur dioxide, particulates and mercury emissions (in each case, expressed in terms of the number of tons of emissions abated per annum), as well as other relevant environmental and health impacts to the citizens of Maryland;
 - (5) An analysis describing any other impacts on residential, commercial, and industrial retail electric customers over the life of the proposed offshore wind project;

- (6) An analysis describing the long-term effect of the proposed offshore wind project on wholesale energy, capacity, and ancillary services markets administered by PJM that includes analysis of contributions to regional system reliability, fuel diversity, competition, transmission congestion, and other power market benefits;
- (7) An analysis describing any other benefits to the State created by the proposed offshore wind project, such as in-state construction, operations, maintenance, and equipment purchases; and
- (8) Other relevant considerations that the OSW applicant elects to include.

Massachusetts

- ALM GL ch. 132B, § 2. Definitions. (Pesticides)
 - "Unreasonable adverse effects on the environment", an unreasonable risk to man or the
 environment, taking into account the economic, social and environmental cost and
 benefits of the use of any pesticide.
- **ALM GL ch. 2 21N, § 4.** Greenhouse Gas Emissions Limits Statewide Plan. [Effective until June 24, 2021]
 - (d) The secretary shall evaluate the total potential costs and economic and noneconomic benefits of various reduction measures to the economy, environment and public health, using the best available economic models, emissions estimation techniques and other scientific methods.

Mississippi

- Miss. Code Ann. § 69-23-3. Definitions.
 - (II) The term "unreasonable adverse effects on the environment", an unreasonable risk to man or the environment, taking into account the economic, social and environmental cost and benefits of the use of any pesticide.

Missouri

- § 640.015 R.S. Mo. Environmental conditions or standards, rules to cite specific law or authority relied upon regulatory impact report required, contents, procedure, not required when section not applicable, when.
 - 2. The regulatory impact report required by this section shall include:
 - (1) A report on the peer-reviewed scientific data used to commence the rulemaking process;
 - (2) A description of persons who will most likely be affected by the proposed rule, including persons that will bear the costs of the proposed rule and persons that will benefit from the proposed rule;
 - (3) A description of the environmental and economic costs and benefits of the proposed rule;
 - (4) The probable costs to the agency and to any other agency of the implementation and enforcement of the proposed rule and any anticipated effect on state revenue;

- (5) A comparison of the probable costs and benefits of the proposed rule to the probable costs and benefits of inaction, which includes both economic and environmental costs and benefits;
- (6) A determination of whether there are less costly or less intrusive methods for achieving the proposed rule;
- (7) A description of any alternative method for achieving the purpose of the proposed rule that were seriously considered by the department and the reasons why they were rejected in favor of the proposed rule;
- (8) An analysis of both short-term and long-term consequences of the proposed rule;
- (9) An explanation of the risks to human health, public welfare, or the environment addressed by the proposed rule;
- (10) The identification of the sources of scientific information used in evaluating the risk and a summary of such information;
- (11) A description and impact statement of any uncertainties and assumptions made in conducting the analysis on the resulting risk estimate;
- (12) A description of any significant countervailing risks that may be caused by the proposed rule; and
- (13) The identification of at least one, if any, alternative regulatory approaches that will produce comparable human health, public welfare, or environmental outcomes.

Montana

- **75-5-703, MCA**. Development and implementation of total maximum daily loads.
 - (1) The department shall, in consultation with local conservation districts and watershed advisory groups, develop total maximum daily loads or TMDLs for threatened or impaired water bodies or segments of water bodies in order of the priority ranking established by the department under 75-5-702. Each TMDL must be established at a level that will achieve compliance with applicable water quality standards and must include a reasonable margin of safety that takes into account any lack of knowledge concerning the relationship between the TMDL and water quality standards. The department shall consider applicable guidance from the federal environmental protection agency, as well as the environmental, economic, and social costs and benefits of developing and implementing a TMDL.

New Hampshire

- RSA 374-G:5. Rate Filing; Authorization.
 - II. Prior to authorizing a utility's recovery of investments made in distributed energy resources, the commission shall determine that the utility's investment and its recovery in rates, as proposed, are in the public interest. Determination of the public interest under this section shall include giving a balanced consideration and proportional weight to each of the following factors:
 - (a) The effect on the reliability, safety, and efficiency of electric service.

- (b) The efficient and cost-effective realization of the purposes of the renewable portfolio standards of RSA 362-F and the restructuring policy principles of RSA 374-F:3.
- (c) The energy security benefits of the investment to the state of New Hampshire.
- (d) The environmental benefits of the investment to the state of New Hampshire.
- (e) The economic development benefits and liabilities of the investment to the state of New Hampshire.
- (f) The effect on competition within the region's electricity markets and the state's energy services market.
- (g) The costs and benefits to the utility's customers, including but not limited to a demonstration that the company has exercised competitive processes to reasonably minimize costs of the project to ratepayers and to maximize private investment in the project.
- (h) Whether the expected value of the economic benefits of the investment to the utility's ratepayers over the life of the investment outweigh the economic costs to the utility's ratepayers.
- (i) The costs and benefits to any participating customer or customers.

New Jersey

- N.J. Stat. § 48:3-87.1. Application to construct offshore wind.
 - (a) An entity seeking to construct an offshore wind project shall submit an application to the board for approval by the board as a qualified offshore wind project, which shall include, but need not be limited to, the following information:
 - (10) a cost-benefit analysis for the project including at a minimum:
 - (a) a detailed input-output analysis of the impact of the project on income, employment, wages, indirect business taxes, and output in the State with particular emphasis on in-State manufacturing employment;
 - (b) an explanation of the location, type and salary of employment opportunities to be created by the project with job totals expressed as full-time equivalent positions assuming 1,820 hours per year;
 - (c) an analysis of the anticipated environmental benefits and environmental impacts of the project; and
 - (d) an analysis of the potential impacts on residential and industrial ratepayers of electricity rates over the life of the project that may be caused by incorporating any State subsidy into rates;

New Mexico

- N.M. Stat. Ann. § 76-4-3. Definitions. (Chapter 76 Agriculture, Article 4 Pesticide Control)
 - S. "unreasonable adverse effects on the environment" means an unreasonable risk to humans or the environment, taking into account the economic, social and environmental costs and benefits of the use of any pesticide

North Carolina

- **N.C. Gen. Stat. § 143-241.1.** Water; water quality standards and classifications; duties of Commission.
 - (d)(4) In revising existing or adopting new water quality classifications or standards, the Commission shall consider the use and value of State waters for public water supply, propagation of fish and wildlife, recreation, agriculture, industrial and other purposes, use and value for navigation, and shall take into consideration, among other things, an estimate as prepared under section 305(b)(1) of the Federal Water Pollution Control Act amendments of 1972 of the environmental impact, the economic and social costs necessary to achieve the proposed standards, the economic and social benefits of such achievement and an estimate of the date of such achievement;

North Dakota

- N.D. Cent. Code, § 61-02-02. Definitions. (Water Commission)
 - 4. "Economic analysis" means an estimate of economic benefits and direct costs that result from the development of a project.
- **N.D. Cent. Code, § 23.1-06-07**. Requirements for adoption of air quality rules more strict than federal standards.
 - o 3. In this section:
 - a. "Cost-benefit analysis" means both the analysis and the written document that contains:
 - (1) A description and comparison of the benefits and costs of the rule and of the reasonable alternatives to the rule. The analysis must include a quantification or numerical estimate of the quantifiable benefits and costs. The quantification or numerical estimate must use comparable assumptions, including time periods, specify the ranges of predictions, and explain the margins of error involved in the quantification methods and estimates being used. The costs that must be considered include the social, environmental, and economic costs that are expected to result directly or indirectly from implementation or compliance with the proposed rule.
 - (2) A reasonable determination whether as a whole the benefits of the rule justify the costs of the rule and that the rule will achieve the rulemaking objectives in a more cost-effective manner than other reasonable alternatives, including the alternative of no government action. In evaluating and comparing the costs and benefits, the department may not rely on cost, benefit, or risk assessment information that is not accompanied by data, analysis, or supporting materials that would enable the department and other persons interested in the rulemaking to assess the accuracy, reliability, and uncertainty factors applicable to the information.

Pennsylvania

- **3 P.S. § 111.24.** Definitions.

 (41) "Unreasonable adverse effects on the environment" means an unreasonable risk to humans or the environment, taking into account the economic, social and environmental costs and benefits of the use of any pesticide

South Carolina

- S.C. Code Ann. § 58-37-10. Definitions. (Energy Supply and Efficiency)
 - o (2) "Integrated resource plan" means a plan which contains the demand and energy forecast for at least a fifteen-year period, contains the supplier's or producer's program for meeting the requirements shown in its forecast in an economic and reliable manner, including both demand-side and supply-side options, with a brief description and summary cost-benefit analysis, if available, of each option which was considered, including those not selected, sets forth the supplier's or producer's assumptions and conclusions with respect to the effect of the plan on the cost and reliability of energy service, and describes the external environmental and economic consequences of the plan to the extent practicable. For electrical utilities subject to the jurisdiction of the South Carolina Public Service Commission, this definition must be interpreted in a manner consistent with the integrated resource planning process adopted by the commission. For electric cooperatives subject to the regulations of the Rural Electrification Administration, this definition must be interpreted in a manner consistent with any integrated resource planning process prescribed by Rural Electrification Administrations.
- S.C. Code Ann. § 46-13-20. Definitions.
 - "Unreasonable adverse effects on the environment" means an unreasonable risk to humans or the environment, taking into account the economic, social and environmental costs and benefits of the use of any pesticide

Utah

- Utah Code Ann. § 19-5-104.5. Legislative review and approval. (Water Quality Act)
 - (3) In reviewing a rule or standard, the Natural Resources, Agriculture, and Environment Interim Committee may:
 - (a) consider the impact of the rule or standard on:
 - (i) economic costs and benefit;
 - (ii) public health; and
 - (iii) the environment;
 - (b) suggest additional areas of consideration; or
 - (c) recommend the rule or standard to the board for:
 - (i) adoption; or
 - (ii) re-evaluation followed by further review by the Natural Resources, Agriculture, and Environment Interim Committee.

Virginia

- Va. Code Ann. § 62.1-44.15. Powers and duties; civil penalties. (State Water Control Law)
 - o It shall be the duty of the Board and it shall have the authority:

- (3a) To establish such standards of quality and policies for any state waters consistent with the general policy set forth in this chapter, and to modify, amend, or cancel any such standards or policies established and to take all appropriate steps to prevent quality alteration contrary to the public interest or to standards or policies thus established, except that a description of provisions of any proposed standard or policy adopted by regulation which are more restrictive than applicable federal requirements, together with the reason why the more restrictive provisions are needed, shall be provided to the standing committee of each house of the General Assembly to which matters relating to the content of the standard or policy are most properly referable. The Board shall, from time to time, but at least once every three years, hold public hearings pursuant to § 2.2-4007.01 but, upon the request of an affected person or upon its own motion, hold hearings pursuant to § 2.2-4009, for the purpose of reviewing the standards of quality, and, as appropriate, adopting, modifying, or canceling such standards. Whenever the Board considers the adoption, modification, amendment, or cancellation of any standard, it shall give due consideration to, among other factors, the economic and social costs and benefits which can reasonably be expected to obtain as a consequence of the standards as adopted, modified, amended, or cancelled. The Board shall also give due consideration to the public health standards issued by the Virginia Department of Health with respect to issues of public health policy and protection. If the Board does not follow the public health standards of the Virginia Department of Health, the Board's reason for any deviation shall be made in writing and published for any and all concerned parties.
- Va. Code Ann. § 3.2-3900. Definitions. (Pesticide Control)
 - "Unreasonable adverse effects on the environment" means any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide.

Washington

- Rev. Code Wash. (ARCW) § 34.05.328. Significant legislative rules, other selected rules.
 - (1) Before adopting a rule described in subsection (5) of this section, an agency must:
 - (c) Provide notification in the notice of proposed rule making under RCW 34.05.320 that a preliminary cost-benefit analysis is available. The preliminary cost-benefit analysis must fulfill the requirements of the cost-benefit analysis under (d) of this subsection. If the agency files a supplemental notice under RCW 34.05.340, the supplemental notice must include notification that a revised preliminary cost-benefit analysis is available. A final cost-benefit analysis must be available when the rule is adopted under RCW 34.05.360;
 - (d) Determine that the probable benefits of the rule are greater than its probable costs, taking into account both the qualitative and quantitative benefits and costs and the specific directives of the statute being implemented;
 - o Seeds, Inc. v. State Dep't of Ecology, 1999 Wash. App. LEXIS 2042

West Virginia

- W. Va. Code § 19-16A-3. Definitions.
 - (47) "Unreasonable adverse effects on the environment" means any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide.

Wisconsin

- Wis. Stat. § 227.137. Economic impact analyses of proposed rules.
 - (2) An agency shall prepare an economic impact analysis for a proposed rule before submitting the proposed rule to the legislative council staff under s. 227.15.
 - (3) An economic impact analysis of a proposed rule shall contain information on the economic effect of the proposed rule on specific businesses, business sectors, public utility ratepayers, local governmental units, and the state's economy as a whole. The agency or person preparing the analysis shall solicit information and advice from businesses, associations representing businesses, local governmental units, and individuals that may be affected by the proposed rule. The agency or person shall prepare the economic impact analysis in coordination with local governmental units that may be affected by the proposed rule. The agency or person may also request information that is reasonably necessary for the preparation of an economic impact analysis from other businesses, associations, local governmental units, and individuals and from other agencies. The economic impact analysis shall include all of the following:
 - (a) An analysis and quantification of the policy problem that the proposed rule is intending to address, including comparisons with the approaches used by the federal government and by Illinois, Iowa, Michigan, and Minnesota to address that policy problem. If the approach chosen by the agency to address that policy problem is different from those approaches, an economic impact analysis prepared by an agency shall include a statement as to why the agency chose a different approach.
 - (b) An analysis and detailed quantification of the economic impact of the proposed rule, including the implementation and compliance costs that are reasonably expected to be incurred by or passed along to the businesses, local governmental units, and individuals that may be affected by the proposed rule, specifically including all of the following:
 - 1. An estimate of the total implementation and compliance costs that are reasonably expected to be incurred by or passed along to businesses, local governmental units, and individuals as a result of the proposed rule, expressed as a single dollar figure. With respect to an independent economic impact analysis prepared under sub. (4m) or s. 227.19 (5) (b) 3., the person preparing the analysis shall provide a detailed explanation of any variance from the agency's estimate under this subdivision.
 - 2. A determination, for purposes of the requirement under s. 227.139, as to whether \$10,000,000 or more in implementation and compliance costs are reasonably expected to be incurred by or passed along to businesses, local governmental units, and individuals over any 2-year period as a result of the proposed rule.

- (c) An analysis of the actual and quantifiable benefits of the proposed rule, including an assessment of how effective the proposed rule will be in addressing the policy problem that the rule is intended to address.
- (d) An analysis of alternatives to the proposed rule, including the alternative of not promulgating the proposed rule.
- (e) A determination made in consultation with the businesses, local governmental units, and individuals that may be affected by the proposed rule as to whether the proposed rule would adversely affect in a material way the economy, a sector of the economy, productivity, jobs, or the overall economic competitiveness of this state.
- (f) Except as provided in this paragraph, if the economic impact analysis relates to a proposed rule of the department of safety and professional services under s. 101.63 (1) establishing standards for the construction of a dwelling, as defined in s. 101.61 (1), an analysis of whether the proposed rule would increase the cost of constructing or remodeling such a dwelling by more than \$1,000. This paragraph applies notwithstanding that the purpose of the one- and 2-family dwelling code under s. 101.60 includes promoting interstate uniformity in construction standards. This paragraph does not apply to a proposed rule whose promulgation has been authorized under s. 227.19 (5) (fm).
- (g) An analysis of the ways in which and the extent to which the proposed rule would place any limitations on the free use of private property, including a discussion of alternatives to the proposed rule that would minimize any such limitations.